V371 10

ADHESIVES AGE

MANUFACTURE, APPLICATION, TECHNOLOGY, RESEARCH AND MARKETING

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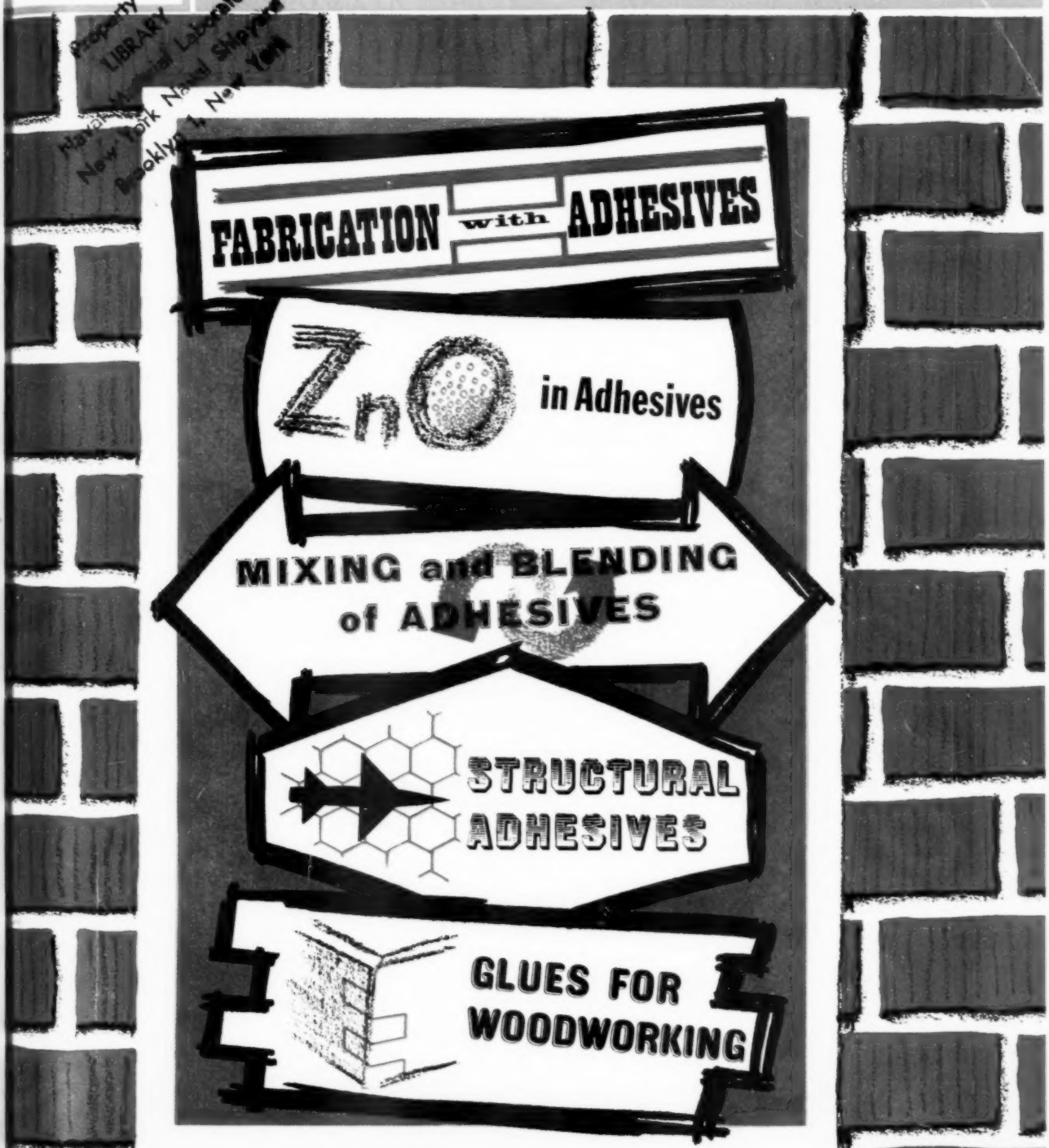

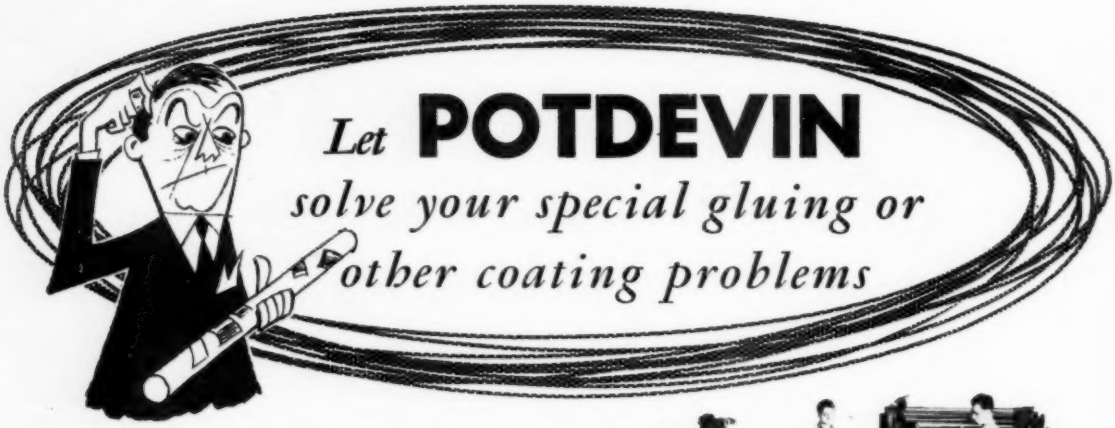

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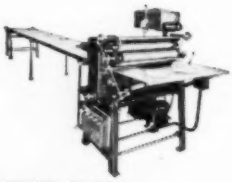
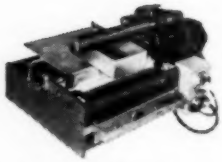


CONVEYOR GLUER

Feeds up to 40 sheets per minute of practically any type of material.

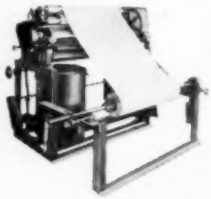


PLATFORM BOX GLUER

Applies coating to platform style boxes up to 3" high.

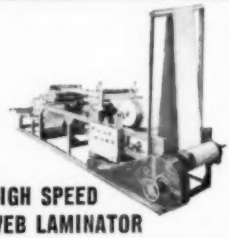
TOPSIDE or UNDERSIDE COATER

Applies solid or strip coating on traveling webs (vertical or horizontal).



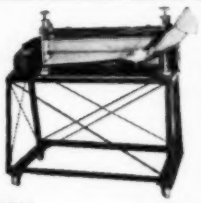
HEAVY DUTY WEB COATER

Applies overall coating to a continuous web of material.



HIGH SPEED WEB LAMINATOR

Laminates rolls of materials up to 20 inches wide at speeds up to 50 feet per minute.



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Type: Synthetic Rubber
Color: Tan
Solids: 18%
Coverage: 350 sq. ft./Gal.
Wet Weight/Gal: 7.1 lbs./Gal.
Shelf Life: 6 months

Vehicle: Stabond "A" Thinner
Temp. Limits: –60° to 350°F.
Consistency: Light Liquid
Tack Period: 2-12 minutes
Flammable: Yes
Toxicity: Semi
Application: Brush or Spray

STABOND C-143

A one component modified Hycar base adhesive for bonding rigid vinyls, natural and synthetic rubbers to itself or to nonporous surfaces such as aluminum, steel, etc. Will bond rubber materials exceptionally well to anodized, alodized or cadmium plated surfaces. Extremely successful on conveyance seating footrests, gear shift and lever boots, cane tips, ferrils, door stops, hand grips, electrical components, etc.

Type: Synthetic Rubber
Color: Tan
Solids: 20%
Coverage: 350 sq. ft./Gal.
Wet Weight/Gal: 7.1 lbs./Gal.
Shelf Life: 6 months

Vehicle: Stabond "A" Thinner
Temp. Limits: –60° to 350°F.
Consistency: Light Liquid
Tack Period: 2-12 minutes
Flammable: Yes
Toxicity: Semi
Application: Brush or dip.

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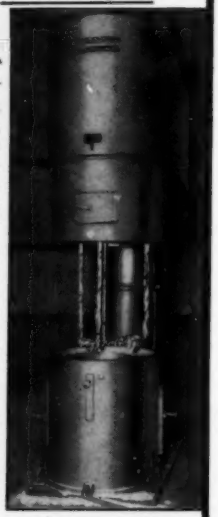
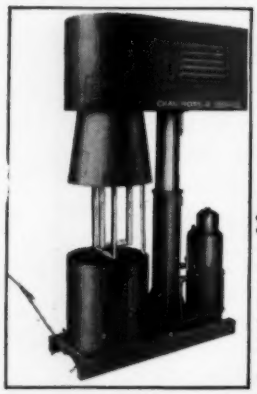


With no bearings or stuffing boxes in the product zone, stationary can, completely enclosed mix, and remotely controlled raising and lowering device, the Mixers are as safe in operation as they are efficient. Mixers have low original and maintenance cost, are easy to clean, and extremely versatile in operation.

Lower Illustration shows an 85 gallon #130-CDM Double Planetary Change Can Mixer furnished a leading concern for mixing plastisols of several types ranging up to 200,000 centipoises. Customer reports Mixer in operation 24 hours/day with mixing time per batch only 15-20 minutes; while the quality of mix and dispersion is so high that the final product is obtained in the Mixer alone — without further processing through a Three Roll Mill as was previously necessary with other Mixers.



Jacketed cans for heating or cooling material during mixing, dolly trucks, gates on cans for discharge, and vacuum tight covers can be provided.

*---or any other heavy paste material. On paints, inks, pharmaceutical products, caulking compounds, and other similar materials, the Ross Double Planetary Change Can Mixers mix and disperse up to 30 times faster than other Mixers.

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ADHESIVES AGE

AA

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Like the old time vaudeville with its "Five Big Acts" each issue of ADHESIVES AGE presents a varied bill designed to inform, instruct and even amuse. Our artist has let his imagination carry this theme into this month's cover in presenting our "big acts."

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PALMERTON PUBLISHING CO., INC.

JANUARY, 1960

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Indexed in Industrial Arts Index and Engineering Index.

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10,600 Copies of This Issue Printed

ADHESIVES AGE is published monthly by the Palmerton Publishing Co., Inc. Printing Office, Bristol, Conn. Editorial and Advertising Office at 101 31st Street, New York 1, N.Y. Subscription in the United States, $5.00 a year; Canada, $5.50; Foreign $6.00; Single Copy, 50¢. January, 1960. Volume 3, Number 1.

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Editorial and Advertising Offices
101 West 31st St., New York 1, N. Y.
Phone: PEnnsylvania 6-6872

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EDITORIAL

Research – A Management Problem

Several of our editors, returning from field trips about the country, report the existence of a research problem on the management level. Now every industry, to a greater or lesser degree, is dependent upon research. The adhesives industry, more than most, hinges upon research. There is no need to belabor this point. What has been happening, however? In many cases, as soon as a research chemist has learned his job and begun to appreciate the problems involved he is "kicked upstairs" to a management responsibility. More often than not, increased remuneration makes the "promotion" impossible to refuse. As an end result, there seems to be a growing number of thwarted research people in our midst.

No one here deprecates the functions of management. No one here has a bad word to say about selling or bookkeeping or inventory control or maintenance. What we are talking about is waste. Waste of talent, waste of opportunity, waste of an opportunity to increase profits.

It is no great secret that in many if not most industries research is considered rather a weak sister, not really necessary but kind of nice to have around. Research groups are often used as recruiting grounds for technical sales people. We firmly believe that the adhesives industry is far more cognizant of research matters than most. At least, we promote our research people. The consequence is the same, however. We are losing some of our best research minds to other departments. What is the solution?

There is obviously no one way to solve the dilemma. A given concern's research program is tempered by such factors as the size of the company; its product line; its net profits, and on its general attitude toward research. It is on this latter point that we would have something to say.

Basic research in the adhesives field is a necessity. There are few, we believe, who would dispute this. Theoretical research may also be a necessity in that it opens new avenues for approach and ultimately new markets. To this end, research is always a management function. Let us not think of research as a training ground for technical sales or purchasing or what have you. Each of these is both an art and a science in itself. Let us see that research assumes the status it deserves. Let there be dignity in the profession and fair return for the researcher. Let there be opportunity for advancement for the individual in research. Let us not rob Peter to pay Paul.

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CONSULTANT'S CORNER

By Dr. Irving Skeist

Question: In processing mineral wool insulation, most manufacturers use a phenolic resin in the preparation of batts or blankets. The coated fibers are oven-cured to bind the fibers together and to get resiliency.

Is there any product which will act as a binder and impart resiliency to mineral wool fibers without necessitating an oven cure? The product should be inexpensive enough to allow it to be a practical substitute for phenolic resins.

Answer: Phenolic resins have earned their place as the favorite binder for mineral wool. They are moderately priced, and the cost can be reduced still further by extending them with terpene resins and resin-coated fillers. The curing temperature can be lowered by incorporating epoxy resins and aliphatic amine hardeners; however, this will make the cost go up.

You may wish to try urea-formaldehyde resins, catalyzed with acids immediately before application. They can be formulated to cure without application of external heat, and they are economical.

Q-129

Question: Your advice is requested in connection with a problem we face in gluing small round (5mm) genuine stones into a cup-like setting which covers only a small portion of the bottom of the stone. As the greater part of the stone is not protected by the walls of the setting, it is easy to push the stone right off. Can you recommend an adhesive which would bond the stone firmly to the setting despite the small contact area? The setting is part of an electroplated piece of jewelry and the stone is glued in after electroplating.

Answer: Try epoxies.

Q-125

Readers who would like to contribute their own experience with problems similar to those discussed in Dr. Skeist's column are invited to write to ADHESIVES AGE, *101 West 31st Street, New York 1, New York. Please refer to the code number given at the end of each question and answer group.*

CONSULTANT'S CORNER

Question: We are looking for a potting compound that will bond a plastic transistor to an aluminum casting. It must be a liquid before curing and flexible after curing. It must have at least 190 BTU/sq.-ft./hr./°F. heat conductivity, be room temperature curing, have a temperature range of from —70°F. to 250°F., 500 psi minimum shear and good flexural strength. Can you suggest an adhesive?

Answer: This question is reminiscent of the problem: what do you buy for the little boy who wants everything? Several extreme requirements are specified, many of them mutually exclusive. High heat conductivity suggests a metallic filler, preferably in fibrous form; but a composition heavily loaded with metal fibers would hardly be a free-flowing liquid. Elastomers which are flexible at very low temperatures are usually deficient in heat resistance. Room temperature cure is likewise an obstacle to heat resistance.

If the "plastic" is one that is amenable to adhesive bonding, and if the specifications can be relaxed considerably, then it may be worthwhile to evaluate a solvent adhesive comprising butadiene/acrylonitrile rubber and phenolic resin in methylethyl ketone, with aluminum powder as conductive filler. Cure one week at room temperature or a few minutes at 275°F. The useful temperature range can be shifted downward, and the flexibility improved, by reducing or eliminating the phenolic resin.

Q-132

Question: Can you recommend an adhesive that will securely bond Teflon-coated fiber glass together. We are enclosing a sample of the material.

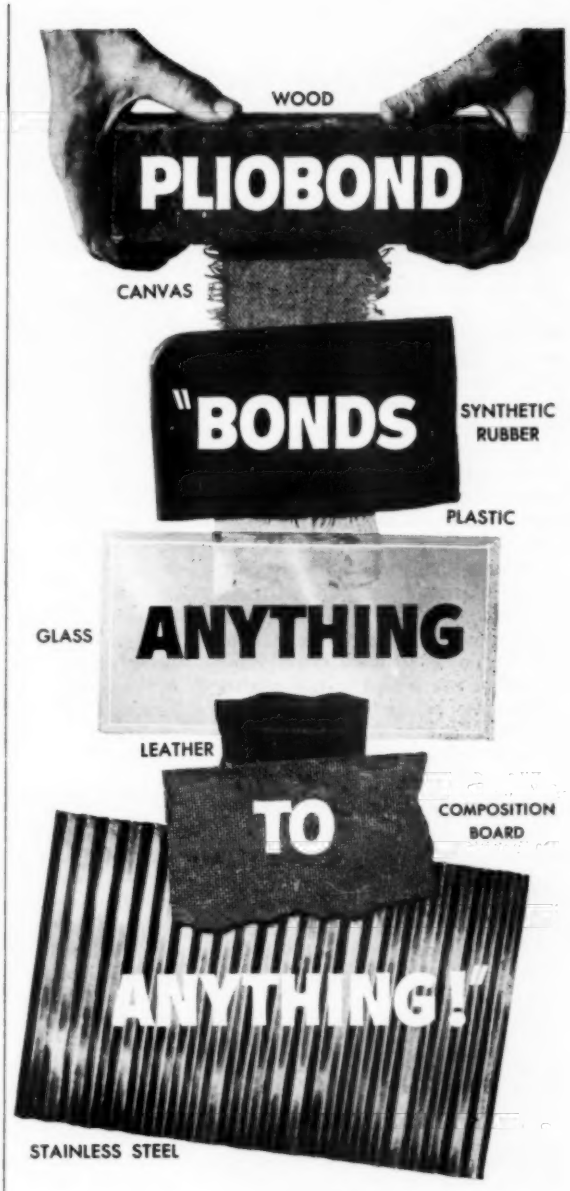
Answer: The sample is of fiber glass completely covered by resin. Teflon is an excellent *ab*hesive, valued precisely because other materials do not stick to it. If a weak bond is adequate, a suitable pressure-sensitive silicone adhesive can be obtained from Dow-Corning.

To render the surface more amenable to adhesive bonding, the Teflon can be treated with metallic sodium dissolved in liquid ammonia. These are two dangerous chemicals, and the DuPont literature should be studied carefully before attempting this treatment.

Finally, you could switch to the composite known as "Armalon," which consists of Teflon calendered to fiber glass so that the glass is partly bare on one side. Via the glass, this laminate can be cemented with an epoxy adhesive available from Rubber & Asbestos Co.

Q-133

Dr. Skeist is associated with Skeist & Schwarz Laboratories, Inc., 89 Lincoln Park, Newark 2, N.J. He is the author of the recently published book, "Epoxy Resins."



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new adhesives

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Devcon 2-Ton Epoxy Glue

A new epoxy glue called Devcon 2-Ton, which has been in use in the aircraft and missile industries, has been introduced to the general market in kit form. Described as "the strongest household glue on the market," a single drop of the glue is said to have supported two tons in laboratory tests. The new epoxy, it is claimed, replaces screws, nuts, bolts, rivets, and even welding. Its white color permits permanent repairs to be made to enamel and porcelain, leaving a gloss finish stronger than the material itself in less than two hours. It does not discolor, is nonshrinking, and resists water and most solvents. Once mixed with a special hardening agent, it is ready for use, requiring no heat or pressure. The finished repair can be matched to the mended original. *Devcon Corp.* **P-233**

Multiple-Hardener Adhesive

The complete range of resins and hardeners contained in the Hysol Select-A-Pak makes it possible for prospective users of epoxy adhesives to inexpensively evaluate them for their particular operation. The selection in-

cludes two clear resins, one filled resin, two one-component systems (liquid and thixotropic nonflow paste) one Hysol epoxi-patch Kit 1C, and five hardeners. The various hardeners allow the user to obtain different viscosities, pot lines, curves and resiliencies. *Houghton Laboratories, Inc.* **P-234**

Heavy Duty Protective Tape

"Scotch" Brand heavy duty protective tape, designated No. 345 (with liner) and No. 346 (without liner), is designed for the heavy duty protection of clad aluminum, other easily damaged metals, and of plexiglas, which are subject to damage from tools, from constant foot traffic, and from equipment being installed. The tape, either lined or linerless, has a high abrasion resistance provided by a rubber-impregnated backing, and can be used up to one year on the job with no adhesive transfer. It can be removed easily, and in one piece. According to the manufacturer, this tape is especially suited for use by aircraft manufacturers. *Minnesota Mining & Mfg. Co.* **P-235**

Contact Cement

Weldwood Super Contact Cement is a non-flammable, non-toxic, water base adhesive which bonds on contact. According to the manufacturer, the cement gives 2½ times more coverage per gallon than solvent types and cuts installation time since only a single coat is needed in bonding plastic laminates, plywood paneling, leather, Novoply, hardboard and fabrics. The adhesive, which bonds immediately and permanently on contact without clamping or pressing, may be brushed, sprayed or rolled, and clean-up involves only soap and water. *United States Plywood Corp.* **P-236**

TSI Tape

Chemically treated pressure sensitive paper tape for use as labeling to be applied to glassware or instruments required by scientists, shows the word "sterile" after heat-treatment. TSI, Time Sterile Indicator, a colorless chemical substance, is imprinted on a white paper pressure sensitive tape. It is said to remain colorless until activated in conditions found in the sterilizing ovens or autoclave. It is reported that the tape cannot be activated by any of the atmospheric conditions. *Professional Tape Co.* **P-237**

Vinyl Coating for Metals

Structural steel and other metal fabrications subject to chemical attack and weathering are said to be made durable and economical to maintain with a spray coating based on Bakelite vinyl resin. It is reported that this vinyl coating has exceptional dielectric properties, making it an excellent electrical insulator. The vinyl resin-based coating resists most petroleum fractions, gasoline, greases, acids and solvents. Applied to surfaces that are clean, dry and free of scale, the coating, which is formulated with a built-in primer, dries to a tough, durable film said to improve appearance in one quick operation. It forms a smooth film, touch-dry in as little as one hour, that adheres tightly to porous and non-porous surfaces. Spray coating of larger areas can be accomplished by conventional pressure pot equipment. For the maintenance engineer, this air drying resin-base coating is furnished in aerosol containers. *Quelcor, Inc.* **P-238**

Epoxy Adhesive

Originally developed for bonding rigid expanded polyethylene foams, Bondmaster M685 can be used for the bonding of metals and rigid plastics in intermediate strength structural applications. M685 is a two-part, room temperature curing formulation, a free-flowing liquid with intermediate strength. At room temperature, a bonded assembly can be handled in 6 to 8 hours and develops 85 per cent of maximum strength in 14 to 24 hours. This formulation may be heat cured in as little as 10 minutes at 250°F. with a hardener. *Rubber & Asbestos Corp.* **P-239**

Insulating Tape

A high temperature pressure sensitive tape, which is resistant to many fuels and chemicals, consists of a 3 mil Teflon backing and a 3 mil high temperature fluoropolymer adhesive. The tape withstands temperatures from —50° to over 400°F. and can be used as protective insulation. *Connecticut Hard Rubber Co.* **P-240**

FOR MORE INFORMATION on the new adhesives described in these columns, use the Reader's Service Card elsewhere in this issue.

Irregular Surface Adhesives

Bostik 2292, 2293 and 2297 are three new adhesives with high solids content and low shrinkage, designed for bonding or sealing of irregular mating surfaces and porous materials. According to the manufacturer, all three adhesives are able to adhere to a variety of materials such as concrete, fabrics, glass, insulating and wallboards, linoleum, metal, paper, plaster, felt, rigid plastic, cork, stone and wood. Resistance to both fresh air and salt water, good aging properties and high resiliency against vibration and impact are claimed for the new adhesives. No staining oils are present in them, and they can be painted over when dry. The 2292 and 2293 are both black in color. The 2292 has approximately 79 per cent solids content and is best applied by trowel or hand gun. The 2293, which can be applied by brush or trowel, has approximately 66 per cent solids content. The 2297 is white, can be applied by brush or trowel, and has approximately 61 per cent solids content. The adhesives are rubber base types, non-curing and gain in strength for 24 to 48 hours after application. *B. B. Chemical Co.* **P-241**

Plastic Steel Adhesive

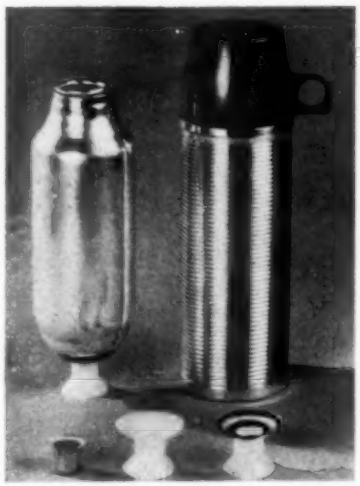
Designed for emergency and permanent repairs to autos, trucks, tractors, trailers, and farm machinery, Plastic Steel is available in a do-it-yourself kit. According to the manufacturer, Plastic Steel will not shrink and is unaffected by gas, oil, or most chemicals. A mixture of 80 per cent steel and 20 per cent improved epoxy, it hardens into a solid steel-like mass in about two hours without the use of heat or pressure. It bonds steel, iron, aluminum, brass, bronze, glass, wood, plastics and porcelain to itself or each other. *Devcon Corp.* **P-242**

Concrete Adhesive

Claimed to be stronger than concrete itself, Helor Hi-Water Epoxy Concrete Adhesive is said to permanently affix anchor bolts, pipes, studs, shelf brackets, hinges and other objects to concrete or masonry. It is also used to repair cracked or broken concrete, and is unaffected by moisture or temperature changes. The concrete adhesive will not crack or shrink after application, the company states. *Epoxy Coatings Co.* **P-243**

Glossy Surface Bondant

Intended primarily for non-structural applications, a new specialty adhesive is now being marketed as a bonding agent for Mylar, polyethylene, glass and other slick-surface, bond-resistant materials which are normally sealed together under a wide temperature range. Designated R-84002, the new adhesive is based



on a hot melt (thermoplastic) type of synthetic resin. Bond is obtained upon solidification; the rate being dependent on ambient temperature and the temperature of the materials being processed. Temperature tolerances for R-84002 are from −20° to +200°F. At 200°F. the adhesive begins to soften, although there may be temperature exposure of 250°F. for short periods without harmful effects. In the photograph above, a polyethylene Tip Protector and Shock Absorber, is bonded to the tip of a glass filler in a thermos. *Raybestos-Manhattan, Inc.* **P-244**

Tailor-Made Resins

Three new Petrothene resins have recently been developed specifically for substrate coating purposes. The resins, Petrothene 200-2, 201-2 and 203-2, are modifications of the firm's three basic Petrothene resins. They have retained the melt index, density, and physical properties of the parent resins but have been modified so that they offer such advantages as greater adhesion in increased coating speeds; reduced beading; less polymer build-up at the die; improved treatability; and reduced smoking and odor. *U.S. Industrial Chemicals Co.* **P-245**

Sealer Kit

Twenty-four individually packaged units of sealers are contained in Epoxylite Sealer Kit No. 1-S. A packaging arrangement simplifies use, insures proper mixing ratios, and provides field convenience. According to the company, because individual units, each containing enough material for a typical repair job, are issued separately, material waste is virtually eliminated. The sealer combines electrical insulating properties and chemical resistance with adhesion to almost all materials. It may be applied as a thin film when rejoining a broken fixture or may be applied in any desired thickness when gap-filling properties are required. The sealer will cure overnight at temperatures above 70°F. or may be cured in a few minutes with heat lamps. Epoxylite Sealer will bond to most metals, glass, ceramics, most plastics, rubber, stone, wood and concrete, and the bond is waterproof, weatherproof, shock and impact resistant, and serves from −65°F. and below to above 200°F. *Epoxylite Corp.* **P-246**

Resin Bonded Quartz Sheet

Resin Bonded Quartz Sheet is a combination of reinforced plastics and ceramics and has high heat-resistant properties. Finely divided particles of fused quartz are bonded together with high temperature resistant Cordo Pyropreg resin and a small percentage of glass or other fiber is included to give the resultant sheet good handling properties. The company recommends using this material as a facing on a laminate of standard Pyropreg reinforced plastic. The sheet is available in thicknesses from 10 to 20 mils and is 36 inches wide. Special thicknesses and widths can be ordered. Roll length is normally 30 to 40 yards, and the materials can also be supplied in a diced form. *Cordo Molding Products, Inc.* **P-247**

Selfix Household Items

Self-adhering plastic household products are adhesive-backed for easy installation. A few drops of water will activate the adhesive backings after which the articles may be affixed in place. Included in this line of products are corner shelves, hooks, soap dishes, utility shelves, curtain rod brackets, and other plastic household products. *Selfix Products Co.* **P-248**

capitol cues

THE OUTLOOK FOR BUSINESS IN 1960 has now taken fairly firm shape in the thinking of economists in both business and government. The forecast is for high prosperity: The new year will see substantial—even boomy—growth. At times, inventory-building may get hectic. Of course, there will be some weak spots. But for most businessmen and consumers, 1960 will be prosperous. (These estimates assume that the steel strike will NOT be resumed in 1960.)

THE BIG BUSINESS GAINS WILL COME IN THE FIRST HALF of the new year. Production of autos and steel will sparkle, particularly, and there will be some solid gains in soft goods. The second half probably will show a marked slowing in the rate of upturn. Home-building will dip and the effect of the federal Budget surplus will show up. But there isn't likely to be a decline.

The economy will get most of its lift from three key sources:

- Business will spend $4-5 billion—15%—more on new plant. Inventory-building will be large, in the wake of the strike. The buying will give business a $10 billion shot-in-the-arm.
- Consumers will spend 5% more in 1960, matching the gain of 1959. Money income will rise 6% but price hikes will dilute this. Salaries and wages will expand; farm income will drop.
- Government policies may exert some drag. Spending may rise $1 billion, with revenues up more. So, instead of pumping in billions, the Treasury will be taking some money out.

THE ECONOMY WILL GROW BY A HEALTHY 6% DURING 1960, measuring in terms of Gross National Product—total output of goods and services. This will lift GNP to $506.5 billion for the year. The first half will see total output at a rate of $503 billion; in the second half, the rate will rise to $510 billion.

Other key business indicators will look like this in 1960:

- Industrial output will increase about 5% during the year, to around 157% of the 1947-49 average. It has averaged around 150% in 1959. Durables, notably autos, will gain the most.
- The number employed will increase by 3% in 1960, rising to an average of 67 million. Gains will center in nonfarm sectors.
- Unemployment will be coming down in 1960 from this year's 3.8 million average to 3.4 million. At times, it will go lower.
- Personal income will be climbing about 5%, to $400 million.

HEALTHY GAINS FOR AUTOS AND OTHER DURABLES are foreseen in the coming 12 months. Auto sales seem sure to top 7 million, compared with 1959 volume of 6.3 million. Higher incomes and the new compact cars will bring virtually all of the lift. Truck sales will go up about 15%, to 1.2 million. Sales of replacement parts will rise nicely, while tire sales will be increasing 10%. (This will include original equipment as well as replacement sales business.)

Economists generally expect sales of homefurnishings to rise during 1960. The gains will range from 7% for furniture and carpets, to 10% for air conditioners, refrigerators, TV sets, radios, washer-dryers, and dishwashers.

EC-1357 cuts costs, makes possible stronger sandwich panels

LABORATORY TESTS show EC-1357 provides the high strength and rigidity called for in nonload-bearing sandwich structures.

3M Adhesive EC-1357 bonds all kinds of skin and core materials *without heat*. You'll speed production, cut costs, build in high strength for non-load-bearing sandwich panels.

You can force-dry the solvent out of the adhesive prior to bonding. And a nip roller or cold press is all that is required to complete the bond.

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ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

PRICE INCREASES DURING 1960 WILL BE MODERATE, in the view of government experts. At the consumer level, they expect the over-all index to rise around 1½%. Services—rents, utilities, medical care, transportation, etc.—will be moving up, along with clothing. Food will fall, but not as much as in 1959. At wholesale, hikes will average 1%, with some drops in farm products tending to offset the broad range of increases anticipated in industrial materials.

> There is another appraisal of wholesale prices worth noting. Experts at the Federal Reserve System are fearful that the wage settlement in steel, plus the rush to build inventories, may push commodity prices up much faster—at a 4% to 5% rate.

LABOR COSTS WILL INCREASE ABOUT AS MUCH in 1960 as they did in 1959. Average hourly pay in manufacturing will go up 8¢, to $2.30. In 1959, it rose 9¢. Several million union workers are assured of this large an increase under deferred compensation clauses written into contracts during past years. These deferred increases are expected to be the target for the rest of labor.

THE NEW YEAR WILL BE A RECORD ONE IN CORPORATE PROFITS. Higher output, big jumps in sales, and an upward trend in prices will lift the net somewhat faster than costs. Profits before taxes may reach $54 billion, as compared with 1959's $48 billion. Productivity is rising and industry is likely to be operating at around 85% of capacity, and this will tend to enlarge margins.

THE TIGHT MONEY SQUEEZE WILL CONTINUE FOR A WHILE—at least through the first half of 1960. Credit will not ease noticeably, but it probably won't get much tighter, either. There'll be big demands for money early in 1960, as business tries to rebuild its inventories. But that is usually a period of seasonal easing, and this will greatly help the economy to get by.

> Note, however, the real possibility that the prime rate—the rate which banks charge their biggest and best customers—may be raised in late Spring, to 5½%. This, in turn, would force up all of the other money rates which businessmen must pay.

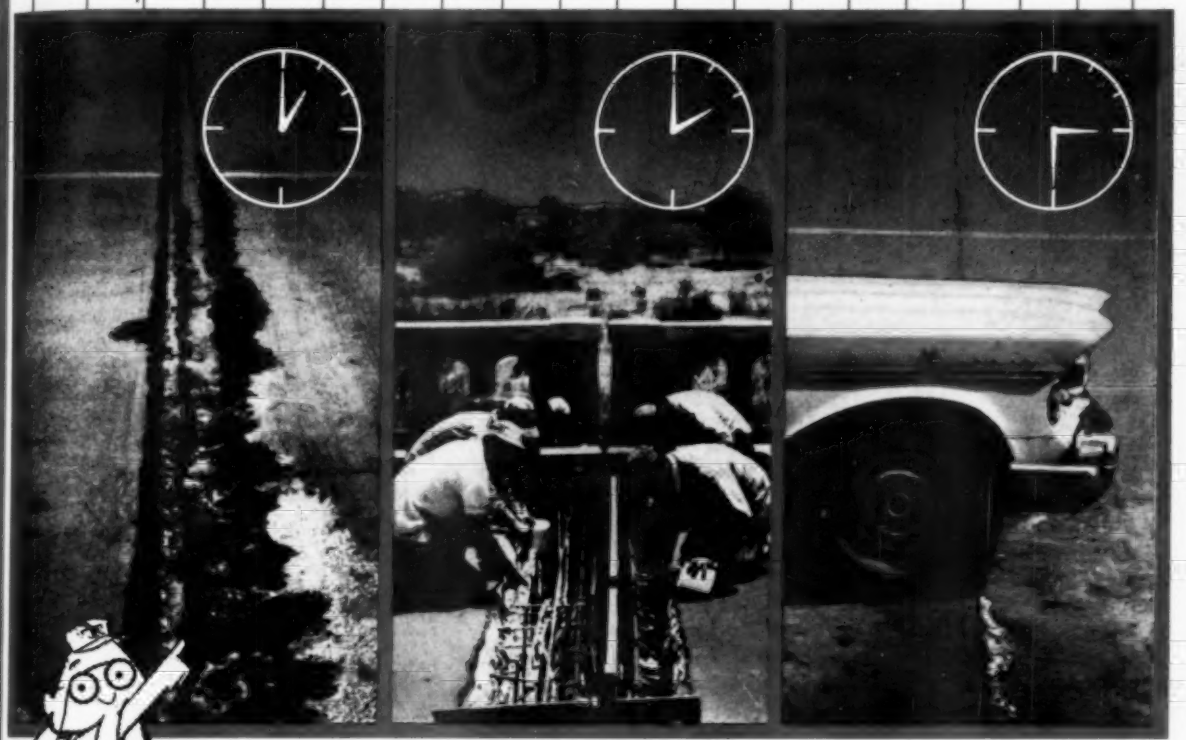
SPENDING FOR NEW CONSTRUCTION WILL DIP A BIT during 1960, despite the expansion in the rest of the economy. The dollar value of work put in place will be down about 1%, to $54.1 billion, from the $54.8 billion for all 1959. Costs will be higher; physical volume of work put in place will fall 3-4%.

- Public outlays by federal, state, and local governments will rise about 2% in the coming year, compared with 1959's gains of 10%. Biggest gains will come in institutional, sewer and water, and military work. Spending for roads will be about the same, while expenditures for public schools will decline.
- Private spending will be going down 3% in 1960, mainly as a result of a sharp dip in outlays for housing. Tight money and the end of government help for low-cost homes will mean a decline in housing starts from 1.3 million to 1.1 million.

There'll be few dips in building materials sales in 1960.

- Cement will do about as well in 1960 as it did during 1959.
- Clay products will drop a bit in sales in the coming year.
- Paints should see sales just about matching 1959 volume.

REPORTS *on concrete bonding with* THIOKOL *LP/Epoxy compounds*



#2 REPAIRING ROAD BREAKS *without causing* BOTTLENECKS

Truly the Achille's Heel of the Highway, spalled expansion joints are a frequent source of road failure throughout the country. Their complete repair by conventional methods generally requires several days, causes hazardous traffic squeezes or inconvenient re-routing.

Many states have found a happy solution to the problem by substituting a THIOKOL liquid polymer/epoxy resin compound for portland cement in remedial work. As pictured above, a spalled expansion joint has been laid bare, the THIOKOL LP/epoxy concrete installed, and the roadway is back in operation in 2½ hours! A job ordinarily taking 3 days! This particular repair was done several years ago and has served perfectly ever since.

Again and again, over a six year period, THIOKOL LP/epoxy compounds have proven their enormous adhesive strength in bonding old-to-old and new-to-old concrete. Repairs made with this material . . . such as patching pot holes, overlaying scaled areas, filling cracks, replacing broken slabs . . . have stood the test of time and wear on well-travelled roads in several states and climates.

It will pay you to find out how THIOKOL takes to the road—easily, quickly and economically. Coupon brings the whole story.

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FOR MORE INFORMATION: Mail coupon to Dept. 23, Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J.

Gentlemen: Please send me available data on THIOKOL LP/Epoxy adhesives for concrete repair.

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• The featured topic at the 10th National Conference on Standards, held in Detroit recently, was "Should American Industry Convert to the Metric System?" Randolph Hawthorne, editor of *Space and Aeronautics*, said it is necessary only to look at the world trend toward the metric system to see that inch-pound users are a distinct and shrinking minority. India and Japan are the latest nations to go metric. Meanwhile, the best English-system countries could do was to patch up the inch-pound definition so that we could have an international yardstick: international, that is, only among the United States and British Commonwealth countries.

Until last July, each of the inch-using countries, Britain, Canada and the United States, had a different inch. By standardizing the inch and pound, the English-system nations have admitted the need for a common standard. Sooner or later, for their own good, Mr. Hawthorne said, these nations are going to have to make the plunge into the metric pool. The time now spent on metric conversion is a drain on industry, in both time and money, and adds to the cost of defense weapons to the taxpayer. Some people felt a change in the metric system would cost too much, while others thought it would repay its cost in the long run. Adoption of the metric system in America, Mr. Hawthorne said, would improve international communications, eliminate the inefficiency of conversions and provide a better mental tool and aid visualization of engineering problems.

Ralph M. Drews, chief metallurgist for the Fabricating Division of the Republic Steel Corp., took the opposite view. He said that conversion to the metric system would entail enormous problems and costs for industry. If the proposed conversion were to be made by adopting existing metric standards, while continuing to manufacture to the inch system for existing requirements, as some proposed, he said, the nation might never get out of the "mess." This would mean redesigning all product standards, and in addition, he continued, it would mean retooling for the entire American industry while maintaining present tooling set-ups for existing equipment and products.

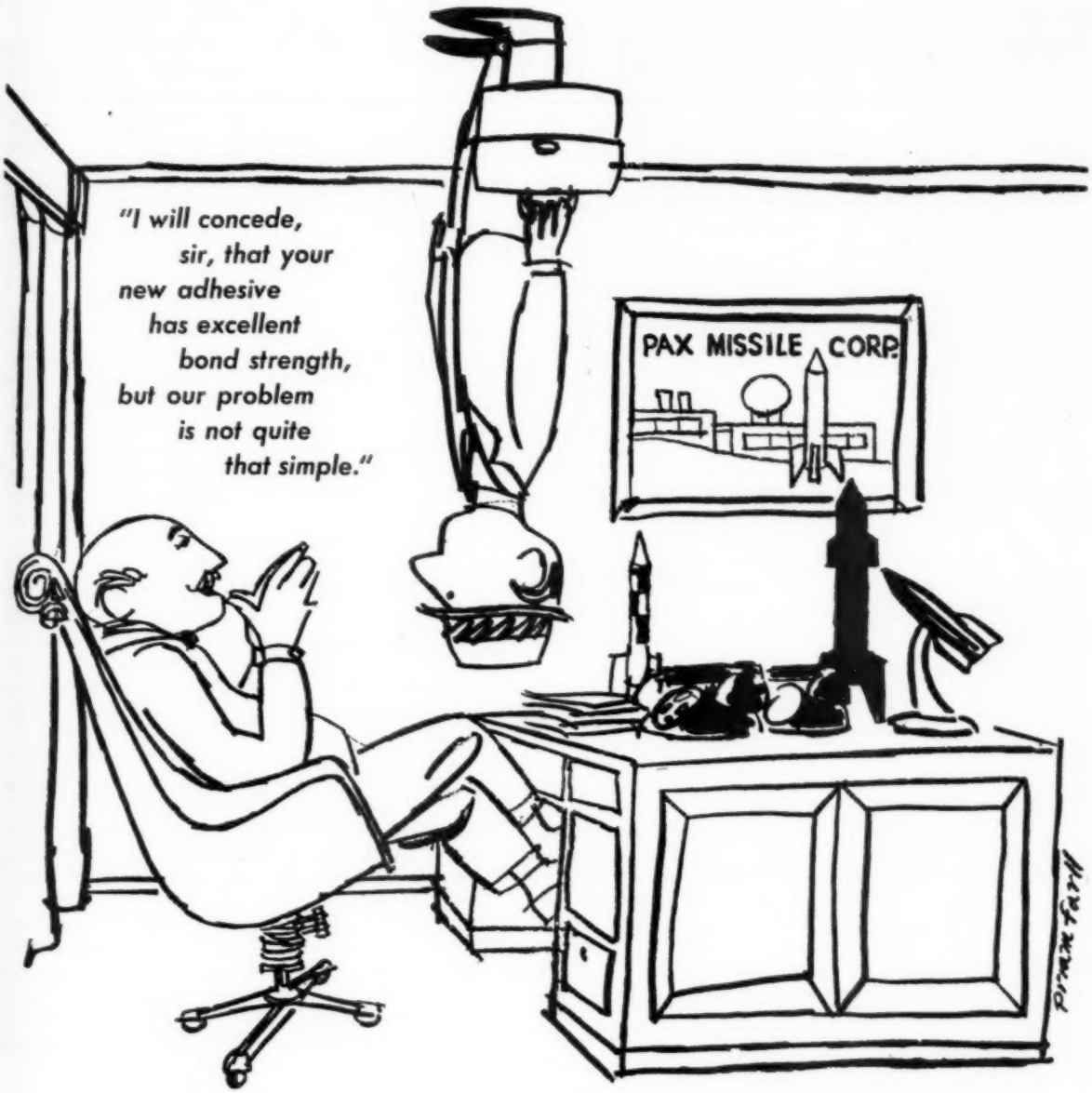
Mr. Drews maintains that neither the general public nor industry is asking for a change to the metric system. He said it would be ridiculous to say that this nation's measuring system had been a handicap to its industrial development and growth. The use of decimals, within the one-inch measurement instead of fractions, gives us the same mathematical simplification that the metric system does, he contended. Although none of our people would benefit by a change to the metric system, Mr. Drews said, the foreign manufacturer could benefit. With lower labor costs he could ship his products, made to metric measurements, to fill orders for customers in the United States. This could be catastrophic to the United States unless some way could be found to compete with these countries without lowering our standard of living. "Today," Mr. Drews continued, "the metric system is doing an excellent job in this country's laboratories—let's keep it there."

We would invite Mr. Drews to take a trip to a number of countries in Europe or to other nations outside the Anglo-American sphere of inch-pound measurements. Looking over some of the catalogs of steel mills and machinery manufacturers in these countries, he might discover that those catalogs are issued in a number of foreign languages, including English, and use two kinds of measurements.

All West German, French, Italian, Swiss, Austrian, etc., steel mills and even small machine shops are willing and able to submit quotations, in American dollars, for the most complicated machinery, using inch measurements. On the other hand, many American companies use the metric system when supplying materials and machinery to foreign countries where the metric system is the established standard. It is true that conversion to the metric system would entail certain costs. But it is inevitable that we will have to spend the energy and money to transform our system to metric standards in the not too distant future. Do we have to wait until England musters the courage for this step?

• A patent covering a method and mold for molding tubular containers from plastic materials has been granted to Regoma Co., Ltd. (Switzerland). A plastic tubular blank is placed in the die of a mold for a head or neck to be attached to the blank and heated plastic material is injected through a passage in the mold opening into the head or neck-forming part of the die. The heated tube end and the newly formed head or neck are thus securely fusion welded. The passage is closed before separating container and die.

• The organization of the European Common Market is the topic of a little encyclopedia by Dr. Albert Oeckl. This book, containing 322 pages, gives a pre-


"I will concede, sir, that your new adhesive has excellent bond strength, but our problem is not quite that simple."
PAX MISSILE CORP.

• Our Mr. Missile Maker speaks for a great many adhesive users who today have "sophisticated" requirements. As a result, the product lines of adhesive compounders are becoming more complex every month.

This means an increasing demand for *quality chemical* raw materials . . . not raw materials for a new "miracle all-purpose adhesive," but raw materials with *precise and predictable properties.* Around such properties adhesives that will meet "sophisticated" demands can be formulated.

One of the best sources for quality adhesives raw materials is Reichhold Chemicals, Inc.

RCI has a full line of *epoxy resins,* phenolic resins and vinyl acetate polymers for professional compounding of adhesives with a wide range of end uses where precision is vital. From a delivery standpoint, you will also be interested in the fact that Reichhold has fifteen plants strategically located across the country. RCI delivers adhesive raw materials in drums, tank cars or tank trucks, and you can often combine shipments for real savings.

If you compound adhesives for customers whose problems are "not quite that simple," investigate the *quality resins* and *emulsions* available from Reichhold.

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Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride • Maleic Anhydride
Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite • Pentaerythritol Pentachlorophenol • Sodium Pentachlorophenate • Sulfuric Acid • Methanol

On the Continent (cont'd)

cise description of more than 1,000 important European and international institutions and organizations. All departments of the United Nations and the six European governments which form the European Common Market are covered. A section is devoted to a description of all the industrial and commercial European organizations. More than 2,600 leading Europeans in important capacities are listed with summaries of their activities and the organization of their offices. Statistical data; information concerning universities and scientific institutes; and many other items of interest are included.

Those interested or those who deal with Europe and the development of the European Common Market will find this encyclopedia an efficient aid in locating the respective organizations, political bodies and other offices which can offer assistance. The book, "Europa-Taschenbuch 1959," costs about $3.00 and is available from Festland Verlag G.m.b.H., Bonn, Postschliessfach 649, West Germany.

• During the International Plastics Convention in London, there was a report on developments in glass reinforced plastics in Germany. It was pointed out that the most widely used reinforcing material is glass fiber, in the form of fabric or matting, having low alkali content. This is used in conjunction with a polyester resulting from the condensation of an unsaturated dicarboxylic acid with ethylene, propylene or butylene glycols. The cross-linking agent is invariably styrene used in conjunction with a variety of polymerizing initiators and activators.

Since a large proportion of the total production is used in roofing applications, it is not surprising that attention is now being paid to the manufacture of transparent reinforced resins which are fire resistant and self-extinguishing. In this respect, polyester resins based on chlorinated carboxylic acids have been developed, but they are not too successful owing to their inferior weathering properties. There is a need for new products in this field and there is also a need to develop better methods for assessing fire-resistance and self-extinguishing properties of these materials.

• In Fort Dix, N.J., a new system of rifle marksmanship training is being used for many recruits. Called Trainfire, it substitutes disappearing targets at various distances for known distant ranges. The system uses sights for 250 meters: the metric system has been substituted for yards in deference to the North Atlantic Treaty Organization. The recruit is trained to aim high or low at targets further or nearer than this distance. Here is another indication that the shrinking oceans will compel us to join the many nations using the metric system.

• The growing trade deficit of almost $4 billion already compels every industry to try its best to increase its export volume. The government is attempting to remove various obstacles which still prevail in many countries regarding American merchandise. However, it will take a concerted effort of almost the entire American industry to wipe out this very unpleasant trade deficit which, if not checked, will endanger the stability of the dollar before long.

There are not enough people who are aware that the United States Commerce Department can help build up and extend exports. The Bureau of Foreign Commerce of the Department of Commerce promotes international trade including export, investments, international travel and other activities. It assists both newcomers in international trade and experienced world traders by providing a business consulting service on the trading countries of the world.

The business information which is available from the Bureau, through the field office network of the Department of Commerce, ranges from comprehensive analytical and statistical reports on all phases of commerce and industry in specific countries to details on such matters as foreign tariff classifications and rates, mark of origin requirements and the preparation of shipments.

The Bureau informs American industry and commerce on new trade and investment opportunities abroad and supplies information on the business standing, facilities and fields of interest of foreign buyers and sellers. Specialized information services are offered on protection of patents, trademarks and copyrights abroad; on all phases of foreign transportation and utilities; and on international insurance matters.

We would recommend a visit to the New York City offices. Visitors will find a helpful staff and a well equipped library containing information on almost every country in the world. The New York office is located in the Empire State Building, 350 Fifth Avenue. The Washington, D. C., office is at 14th Street between Constitution Avenue and E Street, N. W.

• Self adhesive sheets or tapes are covered in a patent granted to P. Baiersdorf & Co., A. G. (Germany). It has been found that intermediate "primer" coatings of mixtures of polyvinyl ethers and acrylonitrile copolymers are outstandingly suitable for producing a firm bonding and anchoring of pressure-sensitive adhesive substances.

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Here are the facts you'll want to know about Vinsol:

- a high-melting thermoplastic.
- saponifiable by alkali to form soaps.
- reactive with aldehydes to form resins.
- dark colored, friable.
- substantially insoluble in aliphatic hydrocarbons.
- compatible with a wide range of resins and plasticizers.

Typical Properties

Melting Point (ring and ball)	112°C.
Acid Number	94
Gasoline Insoluble	83%
Oxygen Absorption	0.25%

Available in lump, flake, pulverized, and emulsion forms—as well as powdered sodium soap—Vinsol is finding ever-increasing use in industry. Further technical data is available from Hercules.

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The advantages of both thermosetting and thermoplastic adhesives may be had with

Polyvinyl Acetal/Phenolic Structural Adhesives

By WELLS WHITNEY
Research Department
Shawinigan Resins Corp.
Springfield, Mass.

and

STEDMAN C. HERMAN
Shawinigan Resins Corp.
Technical Service Representative
Springfield, Mass.

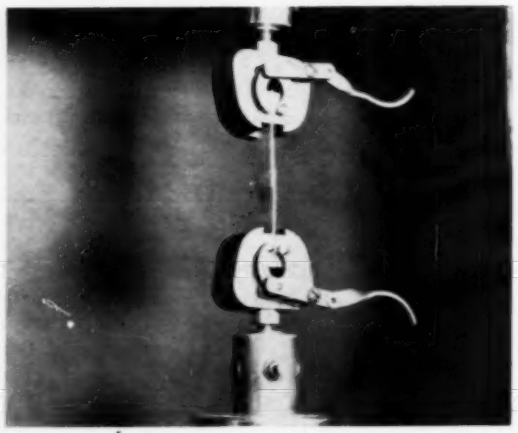
The steady gain in popularity of structural adhesives in recent years has created new industrial interest in the polyvinyl acetal/phenolic type as the solution to many unusual fastening problems. The system has long been in use in bonding aircraft components—in fact it was the first synthetic resin adhesive to be used for bonding metal in structural applications.

One of the major reasons for this quickened interest is the system's versatility. Through the combination of a thermoplastic polyvinyl acetal resin with a reactive thermosetting phenolic, it is possible to obtain a one-package adhesive system which exhibits many of the outstanding characteristics of each component. The balance of acetal resin to phenolic may be adjusted so that the final adhesive characteristics will fit the particular needs of a specific application. Metal-to-metal bonds, brake linings to brake shoes, printed circuits, honeycomb construction . . . all are effective applications of acetal/phenolic adhesives.

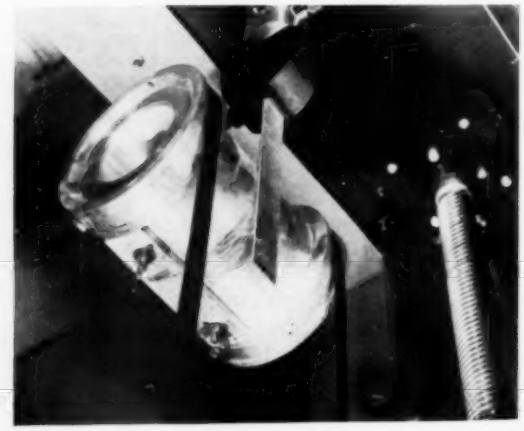
Of the two ingredients, the chemistry of polyvinyl acetals is not so widely known as that of the phenolics. Consequently, some background information is necessary. The resins are, in effect, terpolymers prepared from aldehydes and hydrolyzed polyvinyl acetate. By controlling the conditions of the acetal reaction, polymers containing predetermined proportions of hydroxyl groups, acetate groups and acetal groups can be prepared. Primarily, the acetals from formaldehyde (polyvinyl formal) and butyraldehyde (polyvinyl butyral) are of commercial importance today.

Among the five grades of polyvinyl formal now available in this country, selection may be made according to molecular weight, hydroxyl content and acetate content. For adhesives work, a high molecular weight, low hydroxyl, low acetate polyvinyl formal resin is preferred.

Laboratory Testing of a Structural Adhesive Bond



Testing the bond shear strength of a Formvar/phenolic adhesive. Average values for such an adhesive system range from approximately 4500 to 5500 psi.



A climbing peel tester is used to evaluate the peel strength of a Formvar/phenolic system. Average strength values obtained are 14 to 18 pounds per inch width.

Six molecular weight grades of polyvinyl butyral are presently commercially available in this country. The acetate content of butyral resins generally is quite low, but variations occur in hydroxyl content as well as in molecular weight. All grades have been used successfully in adhesives systems with some preference shown to those with high hydroxyl content.

Assuming that adequate wetting and fusion has taken place during adhesive application, the final bond strength is determined largely by the physical properties of the adhesive, provided that there is a minimum of adhesive shrinkage and subsequent internal strains. The cohesive strength of the adhesive must provide the necessary strength and rigidity to the joint. This strength varies from weak secondary (Van der Waal Forces, etc.) to strong primary (chemical bonds) linkages.

Thermosetting phenolics, with their strong three dimensional cohesion and numerous polar groups attached to the chain structure, are excellent starting points for structural adhesives. Used alone, however, phenolics are too hard and inflexible to be satisfactory for many applications. The addition of a thermoplastic acetal resin significantly improves flexibility and toughness. Because of the interaction of acetal and phenolic resins, very little cohesive strength is sacrificed for the vastly increased toughness and flexibility of the combined system.

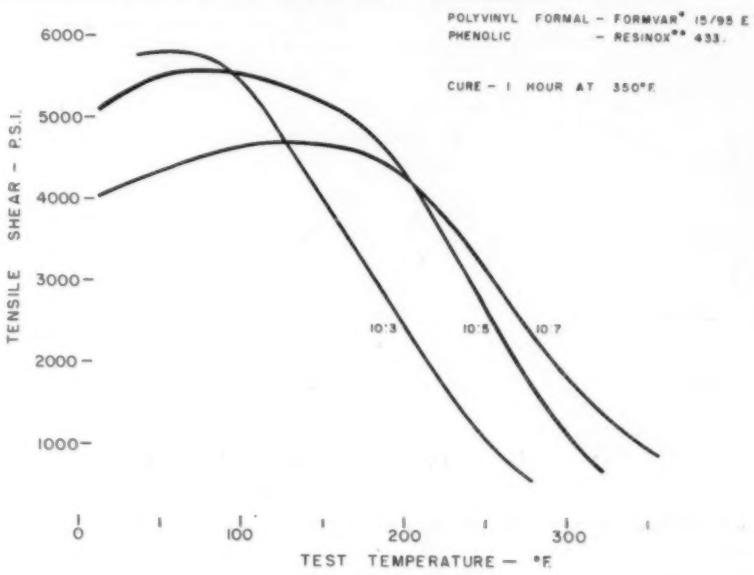
For structural adhesives, polyvinyl acetal resins are normally used with alkaline catalyzed phenolic laminating varnishes which are usually supplied as 60-80 per cent solids solutions in alcohol.

Acetal : phenolic ratios of from 10 : 3 to 10 : 20 have been used successfully for structural adhesives. (The amount of phenolic in the ratio is based on the phenolic solids.) As the amount of phenolic in an adhesive is increased, the elastic modulus of the adhesive increases and the tensile strength rises to a maximum, then decreases.

The room temperature tensile strength maximum is at a ratio of about 10 : 4. Additional phenolic tends to induce more adhesive shrinkage during cure, thereby introducing internal strains which lower the tensile strength. The effect of varied acetal/phenolic ratios on tensile shear at different temperatures is illustrated in Figure 1.

There are large strength differences between the two acetal types and also within a particular type. In general, the polyvinyl butyrals are the more flexible, more thermoplastic of the two. Adhesives based on polyvinyl butyral have the higher peel strength. Room temperature shear strength of polyvinyl butyral adhesives is approximately equal to that of polyvinyl formal based adhesives. But in the case of polyvinyl butyral, shear strength falls off more rapidly at high temperatures.

Figure 1—Effect of Varied Polyvinyl Formal/Phenolic Ratios



Special Advantages

The advantages of the butyrals also include better low temperature flexibility and wider solubility characteristics. An increase in molecular weight of a given resin generally gives better shear strength as does a decrease in acetate content. The influence of resin type on strength properties is shown in Figure 2.

The acetal resins used were all of approximately the same degree of polymerization. Butvar B-90 is a polyvinyl butyral resin with a hydroxyl content of 18-20 per cent and an acetate content of 1.0 per cent maximum. Formvar 12/85, a polyvinyl formal, has a hydroxyl content of 5-7 per cent and acetate content of 20-27 per cent. Formvar 15/95E, also a polyvinyl formal, has a hydroxyl content of 5-6 per cent, and an acetate content of 9.5-13 per cent.

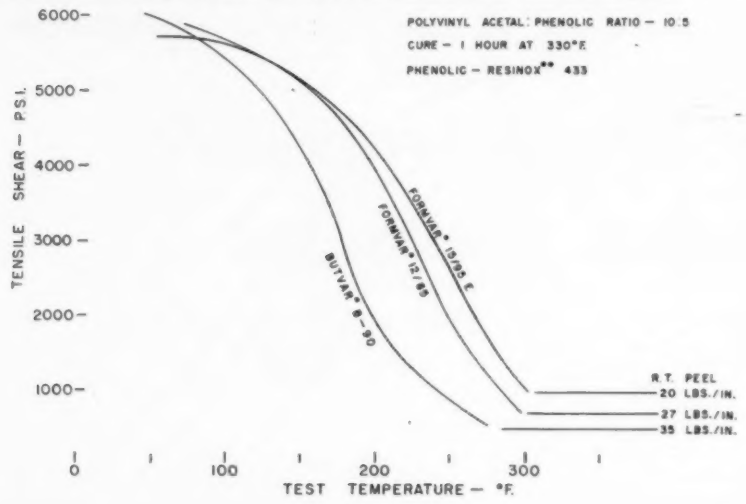
The time and temperature of cure greatly affect shear and peel strengths. Initially, both peel and shear strength rise as the system begins to cross-link. With aluminum, the room temperature shear of about 6000 psi is significantly above the yield point of the metal. The high temperature shear increases with increasing cure more rapidly at first; room temperature shear increases at first, reaches a maximum, then levels off. This cure vs. strength relationship is illustrated for a formal/phenolic adhesive in Figure 3.

From the preceding data, it can be seen that acetal/phenolics are quite stable under conditions of accelerated high-temperature aging. Slight loss of flexibility is sacrificed for vastly improved high temperature strength.

Creep-rupture strength is related to high temperature shear and can be improved by increase of cure, more phenolic or proper choice of acetal resin.

The choice of solvents in a solution adhesive is important both for viscosity control and for proper drying and filming characteristics. Proper drying of the adhesive film is very important since a small amount of residual solvent can greatly affect final properties. Yet the solvent cannot be so volatile

Figure 2—Effect of Acetal Type on Shear and Peel Strengths



that blushing takes place—sprayed films are much more sensitive to bushing than other film types.

The solubility of acetal resins in a particular solvent depends, to a large extent, on the types and amounts of functional groups present in the resin type and grade.

Polyvinyl butyral resins generally are soluble in alcohols, glycol ethers and certain mixtures of polar and non-polar solvents. The polyvinyl formal resins, on the other hand, are not soluble in alcohols, but are soluble in such solvents as chlorinated hydrocarbons, dioxane and aromatic-alcohol blends.

In formulating structural adhesives from polyvinyl butyral, most of the common alcohols can be used as the principal solvent. For polyvinyl formal adhesives, a combination of solvents usually is required. The following formulations, in parts by weight, are typical solvent systems for polyvinyl formal:

50 ethylene chloride
25 95 per cent ethanol
25 methyl ethyl ketone

40 95 per cent ethanol
30 ethylene chloride
30 dioxane

40 95 per cent ethanol
60 toluene

These solvent systems were developed for brushing at a polyvinyl formal solids content of 12-15 per cent.

For spray application, a slower evaporating solvent system and a lower solids content are necessary. Diacetone alcohol, cellosolve acetate, ethylene chloride mixtures in the range of 5-10 per cent acetal solids will spray well. In addition, higher boiling alcohol-aromatic combinations work well. It is possible to increase greatly the solids content for certain application methods such as flow coating, extrusion, and tape impregnation. As a general rule, enough adhesive must be applied to give a dried adhesive film of 3-10 mils.

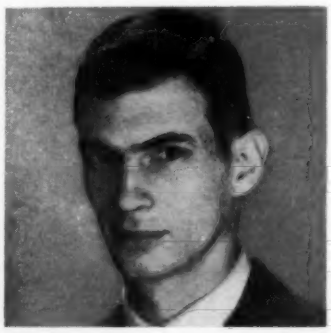
When the adhesive is applied in solution, it is necessary to remove all solvent before the bonding operation. For complete removal, a short air dry followed by an oven dry at 200-225°F. is satisfactory. Other drying methods such as infrared lamps can be used but care should be taken that temperatures of over 250°F. are not maintained too long or the adhesive cure will progress too far for adequate bonding.

Variables Eliminated

The use of an adhesive tape system for bonding structural components eliminates the variables associated with the usual brush or spray application of the adhesive. Moreover, the additional bulk available from the tape itself reduces the possibility of a poor bond due to insufficient filling of the glue line.

The curing schedule of an acetal/phenolic adhesive is determined largely by the curing rate of the phenolic used and the final bond qualities desired. The reactions between the polyvinyl acetal and the phenolic resin are complicated, involving self-condensation of the acetal resin, the phenolic resin and co-condensation between the two. These re-

About the Authors . . .



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actions proceed largely through the hydroxyl groups of the acetal and the methylol groups of the phenolic with water being split off (*1*).

Methods for applying heat and pressure are almost unlimited, with presses, ovens and autoclaves being used. Choice of equipment is more dependent on the size and shape of the bonded part than on the adhesive used. For acetal/phenolic adhesives, a temperature of at least 280°F. is necessary to obtain adequate flow and fusion of the adhesive. The cure time can be shortened with higher temperatures: a cure of 400°F. for three to five minutes being the high extreme. For most general adhesive work, a cure of ¼-½ hour at 325°F. is sufficient. For some high strength aircraft applications a longer cure of one to two hours at 350°F. is employed.

One of the major factors in adhesive selection is a thorough knowledge of the adhesive strength properties. In evaluation of any adhesive there are numerous tests involved, dependent on the adhesive-adherend system and the conditions of use. Since, historically, most metal-to-metal structural adhesive work and experience has been with airframe bonding, the adhesive specifications most used are those of the Air Force MIL-A-5090B, MIL-A-8431 and MIL-A-25463. These specifications include shear strength (from 67° to 500°F.), peel strength (from 67° to 180°F.), creep-rupture, bend or flexure, and various exposure and immersion tests. Acetal/phenolic adhesives are now qualified under MIL-A-5090B and also pass many of the tests for MIL-A-8431 Type I and MIL-A25463 Type II (300°F.).

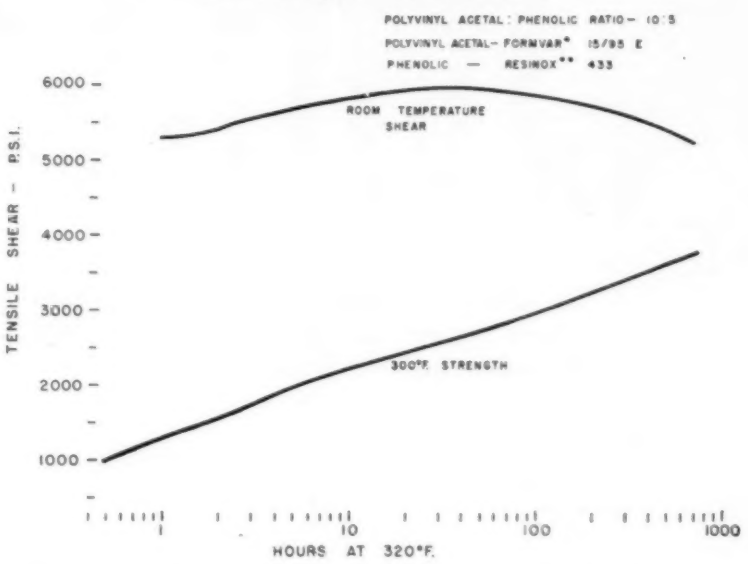
Printed Circuit Bonding

Acetal/phenolic adhesives have also been used extensively in printed circuit bonding, the most important qualifying tests being electrical insulating resistance, peel strength, and blister resistance. These tests have been standardized by the American Society for Testing Materials in conjunction with the National Electrical Manufacturers' Association.

Assemblies for use in building construction have to withstand atmospheric exposure of all kinds and various tests have been introduced. The field is too new and problems too varied, though, for any test standardization yet.

In making a bond for testing, one of the most important points is that

Figure 3—Effect of Cure at 320°F. on Tensile Shear Measured at Room Temperature and 300°F.



the surfaces be as clean as possible of dirt and oil and contaminated film. The cleaning method will depend on the chosen adherends.

Care should be taken to avoid contamination of the cleaned surface and the adhesive should be applied as soon as possible. The adhesive coated adherend can then be stored for long periods of time before final assembly.

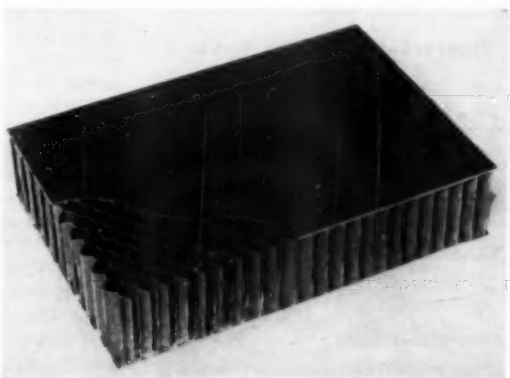
From the adhesive standpoint, several things can be done to improve wetting action to specific surfaces. Certain chemical groups have better wetting action towards specific surfaces than others. The polyvinyl acetals, with their variety of chemical groupings, adhere well to many surfaces. Sometime during the bonding operation, though, it is necessary to make the adhesive fluid enough to thoroughly wet the surface. This is done by either solvating the resins or by application of heat and pressure to a 100 per cent solids film.

The results reported in this paper were obtained with Alclad Aluminum prepared in accordance with treatment WAC-1 described in WADC-TR-55-87, see Literature, Reference 2.

Literature References

(1) Cohen, et al, "Industrial and Engineering Chemistry," Vol 50, 229, February 1958.

(2) WADC Technical Report 55-87, "Treatment of Metal Surfaces for Adhesives Bonding" (The Franklin Industrial Laboratories for Research and Development).



Polyvinyl acetals are used by Douglas Aircraft Company in the production of their honeycomb core panels which are marketed under the name of "Aircomb."

JOINTS

To obtain maximum efficiency from adhesive bonds, joints must be designed specifically for the type of material, the fastening method and the end use

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To derive the maximum benefits from the properties of adhesives and to minimize the effect of the shortcomings or weak points, joints to be bonded must be designed properly. Although acceptable assemblies have been made where joints were designed for other methods of fastening, or where inefficient design was made necessary by other considerations, certainly the best performance may be expected from an adhesive in assemblies especially designed for bonding.

The size and shape of a part to be bonded is determined by the end use. Often, other design considerations may not allow the most effective joint design but for maximum effectiveness and success, the joints should be designed to:

(1) Minimize stress on the adhesive.

(2) Stress the adhesive in the direction of its maximum strength.

(3) Minimize stress in the direction the adhesive is weakest.

(4) Make the maximum proportion of bonded area contribute to the strength of the assembly.

(5) Maintain continuity of bond.

(6) Be adaptable to production techniques.

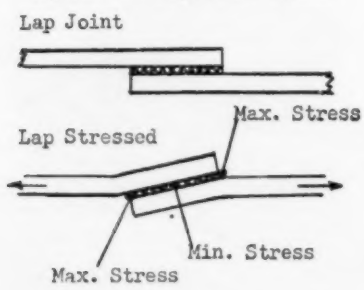
Adhesive behavior under stress conditions indicates the desirability of certain features in joint design, and the undesirability of others. Specific strength values obtained with test specimens of a given area and geometry of bond cannot be translated readily to other geometries, areas or materials.

The strength of an adhesive under short time loading gives no indication of the performance of the adhesive under continuous stress. Adhesive strength as determined shortly after the bond is made may be no indication of the strength after exposure of the bond to aging of environmental conditions.

In designing, consideration must be given to the strength of the adhesive under the stress conditions and environmental conditions to be encountered and actual parts must be tested. In addition, because the apparent strength of joints made under what may be considered identical conditions varies over a relatively wide range, statistical analyses of strength may be required before an efficient design can be produced. The elastic constants of adhesives are generally unknown and while they would be of great value to the design engineer, he usually must proceed without such information.

It becomes obvious that the knowledge about adhesives as materials of construction is not as extensive as for conventional materials. This article is intended to cover only guide posts for the designer rather than specific design criteria.

Figure 1—Lap-Joint Stress



Metal Joint Designs

The major factors influencing the choice of design of a metal to metal joint are duration, magnitude, and direction of the load to be applied to the joint. Since most of the adhesives used for bonding metal to metal are relatively rigid, strong in shear and weak in peel or cleavage, joints usually are designed to place the adhesive in shear and prevent or minimize peel or cleavage stresses.

Flat plates or sheets are rarely bonded in a manner to place the adhesive in tension, although heavy sections or blocks certainly could be designed in tension when cleavage stresses can be minimized. The magnitude of stress in shear influences the area of the bond required, and where maximum stresses are involved, influences the geometry of the joint.

The most common method of assembling flat plates or sheets is

Figure 2—The Effect of Overlap

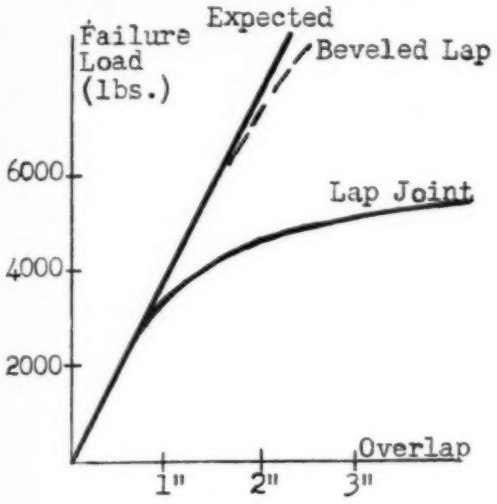
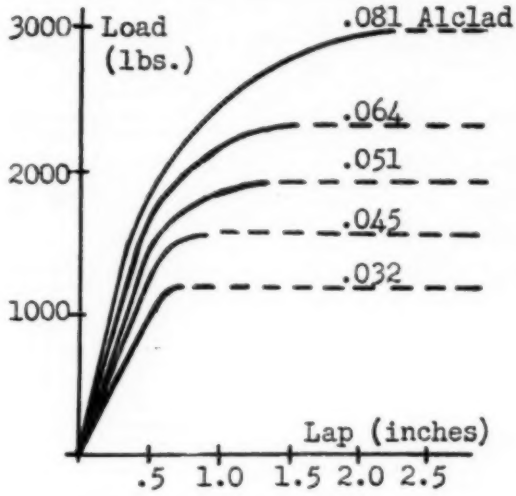


Figure 3—Effect of Metal Thickness



through the use of a straight lap shear joint. As can be seen in Figure 1, with the metal in tension under stress and the adhesive presumably in shear, there is a tendency for the edges of the lap to deflect. This is because the stress in the sheet is maximum where it enters the joint and decreases to little or nothing at the end of the sheet at the other edge of the joint. The adhesive at the edges of the lap is therefore placed under tension stress and tends to peel the bond apart. As a consequence, the failure loads observed on metals which can deform in this manner are substantially below the true strength of the adhesive.

A high proportion of the failure load in lap joints is carried by the edges of the lap. This is illustrated by the fact that an adhesive showing an apparent bond strength of 3,000 psi with a 1" overlap, will fail at about 2,500 pounds when only the edges of the lap are bonded with a ¼" stripe of adhesive on each edge. The interior ½" portion of the lap contributes only about ⅛ of the total strength of a 1" overlap in this particular case. For this reason, it is quite important that the edges of lap joints be well bonded with good contact. The center portion of the overlap assumes lesser importance.

The strength of a lap joint in shear (with the metal in tension) is directly proportional to the width of the joint. For example, with depth of lap and gauge of metal constant, a joint 2" wide will be twice as strong as a joint 1" wide. The strength of a bond may, therefore, be increased by increasing the width of the lap.

Strength also may be increased by increasing the depth of the overlap, but the relationship is not linear. Since the edges of the lap carry a relatively high proportion of the load and the interior area of the bond carries a lesser proportion, it is evident the unit strength realized as overlap increases will gradually become lower. Eventually, a depth of lap should be reached beyond which no further increase in strength could be expected. Figure 2 illustrates a typical relationship between failure load and overlap, compared with the failure loads which might be expected if the relationship were linear.

No significance should be ascribed to the failure loads on an absolute basis as these will be different for each adhesive and for each gauge and type of metal bonded. However, the general shape of the curve is important. It is evident the law of diminishing returns sets in and the depth of lap is finally reached beyond which the strength of the joint cannot be increased.

If greater strength is desired than may be obtained at the depth of lap and width of lap that is practical, the designer may resort to a change in the gauge of metal. He also may change the design to a more efficient joint.

The strength of a lap joint depends not only on the depth of lap, but also on the thickness of metal and yield strength of the metal. With adhesives which may exhibit a tensile shear strength of several thousand psi, the yield strength of thin gauge metals is exceeded at relatively short overlaps. Since the yield strength depends on the modulus and thickness of metal and varies from metal to metal, it is evident that the lap required to exceed the yield strength—which is the maximum strength one may expect to obtain—will vary with the thickness and type of metal.

Figure 4—The Use of a Rivet to Cut Down on Peel Stress

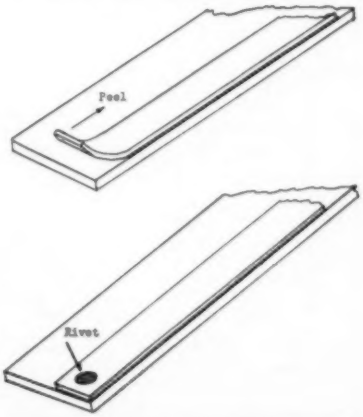


Figure 5—Joints for Flat Metal Plates

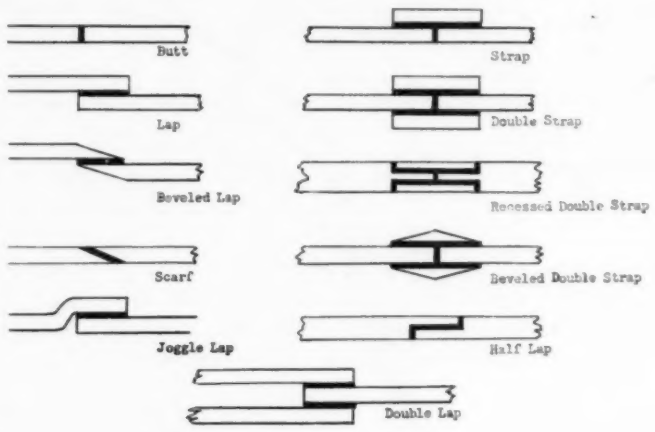


Figure 6—Avoiding Peel by Changing Base Sheet Stiffness

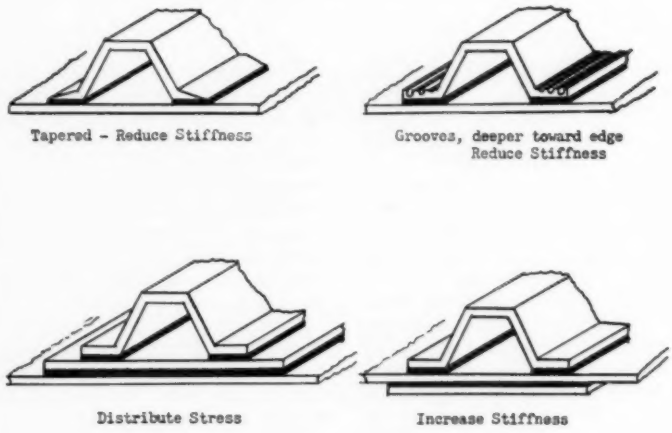
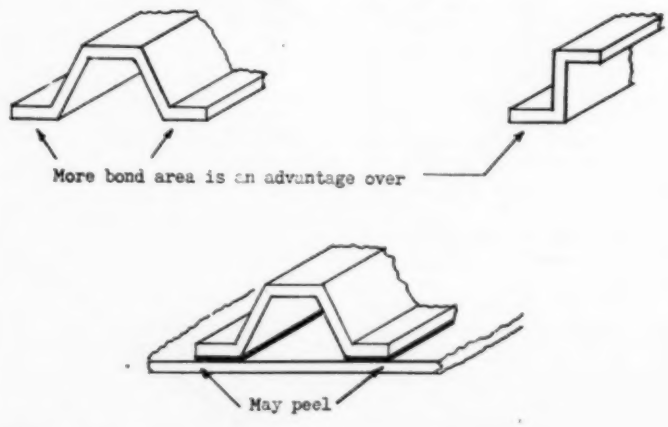


Figure 7—Avoiding Peel by Changing Stiffness of the Flanges



This holds true up to the point where the thickness of metal is such that the strength of the metal cannot be equalized by the apparent strength of the adhesive at any overlap. The inter-relationship among failure loads, depth of lap and thickness of metal for a specific adhesive with a specific metal is shown in Figure 3. Curves may vary somewhat with other adhesives, so the failure loads have no significance to the designer other than to illustrate the relationship.

The strength of lap joints and other types of joints depends also on the thickness of the adhesive film which may be characteristic for each product. Although it is commonly believed that the strongest joints are made with the thinnest films of adhesives, optimum film thicknesses can exist. This is evidenced by the well-known reduction in strength which occurs with heavy thicknesses of adhesive, and the poor bond strengths obtained with "starved" joints.

Type of Stress

Before a decision can be reached on the optimum film thickness desired, consideration must be given to the type of stress the joint must withstand. Difficulties from creep may be greater for thicker adhesive films. Relatively thin adhesive films may show the highest shear strength and heavier film thickness may improve impact and peel properties. It is, therefore, important that faying surfaces be free of grooves, slots, and waviness, and protuberances or bosses that may interfere with the attainment of the optimum film thickness.

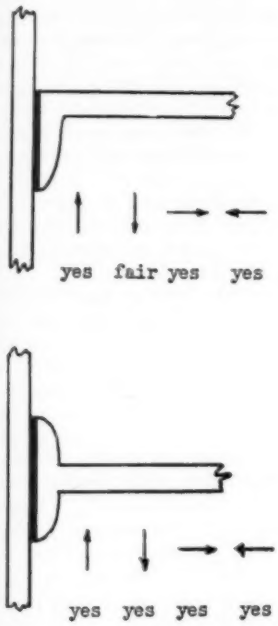
The strength properties of lap joints in thin metals may be improved through the judicious supplementary use of rivets as well as adhesive. Improvements in shear strength, impact, deflection, permanent set, and fatigue properties, may be realized. Rivets may also be useful for preventing peel from starting in joints, as illustrated in Figure 4.

It should be noted, however, that the combination of rivets and adhesive must be evaluated in the specific assembly. Limited experience has shown, in some instances, that weaker assemblies can result from such a combination.

A variety of joint designs have been proposed. Some which can be of value in specific design problems are shown in Figure 5.

A scarf joint is the most efficient. It affords uniform stress distribution over the entire bonded area, and

Figure 8—Joint Angles for Reducing Cleavage



eliminates the stress concentrations found in the lap joint. The beveled lap also demonstrates good stress distribution. Examination of the bevel lap reveals the strength advantages to be realized from this type of lap over the plain lap joint.

However, both the beveled lap and the scarf joint present problems in production. Machining operations are quite difficult with thin metal. The feather edges tear readily and the application of bonding pressure to the beveled lap is difficult. The direction of stress application may indicate the advantages of one joint over another.

Offer special Advantages

For example, the double strap or recessed double strap joint offer advantages under bonding stresses. Similarly, a double strap joint with plates butting can be very good in compression, where some of the other joints may be weak. It should be remembered that reduction in the thickness of metal, such as required for half lap or recess strap joints also reduce the tensile loading (shear in the adhesive) the joint can stand.

Dissimilar adherends may be bonded with a scarf joint with minimum sacrifice of uniform stress distribution if the ratio of the thickness is inversely proportional to Young's moduli. Peel stresses exerted on rigid adhesives can cause failure. Some of the structural adhesives, however, are better in this respect than others. Proper design, too, can help in this respect.

In the attachment of stiffening members to thin sheets as is common in aircraft construction, the sheets deflect in service and peel stresses are exerted on the adhesive. If the flanges on the stiffening section can deflect with the sheet, minimum difficulty from peel would be expected. Either increasing the stiffness of the sheet, or reducing the stiffness of the flange on the stiffening section should result in improvement. Figures 6 and 7 illustrate in principle how stiffness may be changed to minimize peel. The sections illustrated, however, are not necessarily intended to be readily adaptable to aircraft problems, as production difficulties may exist.

In the bonding of heavy sections, the parts should be designed so that the adhesive is in shear, as with flat sheets. But if the bond can be placed in pure tension, this too should be satisfactory. However, this is most difficult to arrange, as usually cleavage stresses result. Typical approaches to the reduction of cleavage are illustrated in Figure 8.

Angular joints, such as corners, also give rise to either peel or cleavage stresses, depending on the gauge of material used. Here, reinforcement

Figure 9—Reinforcement of Corners

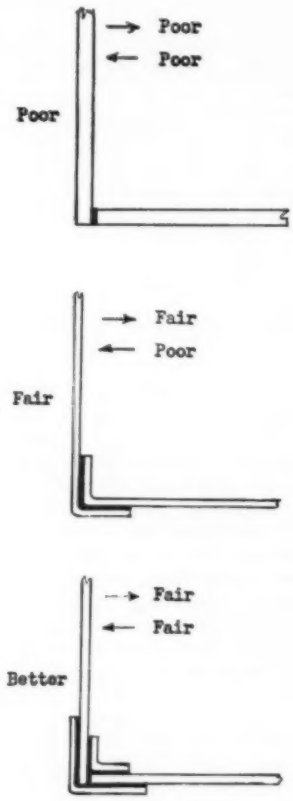


Figure 10—Recessed Butt-Joints for Solid Rods

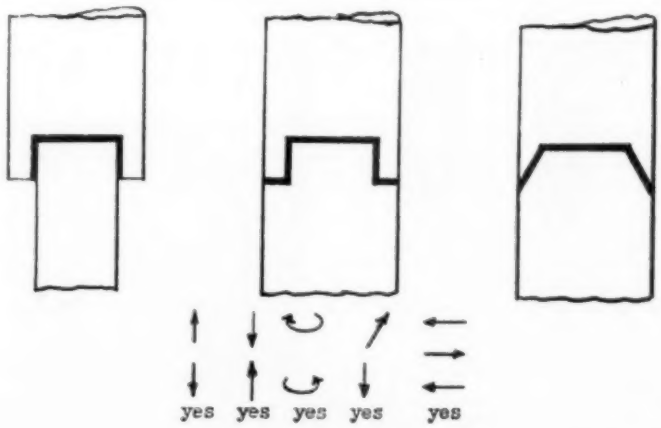
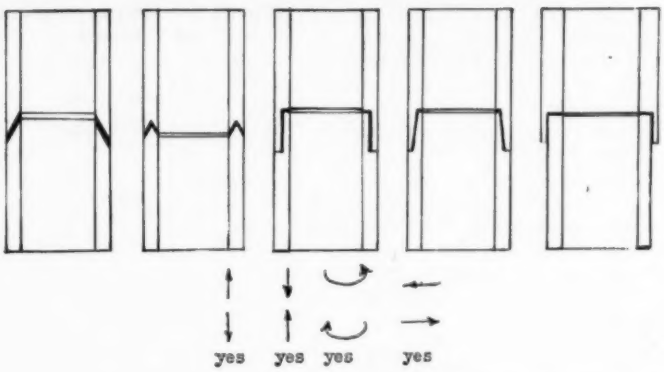


Figure 11—Joints for Cylindrical or Tubular Materials



of corners is desirable to accomplish improvement as shown in Figure 9.

The butt joining of solid rods might be expected to result in generally satisfactory performance in compression, tension, and torsion, if the stresses were true. However, cleavage forces in such assemblies are the rule rather than the exception. Better performance is obtained through the use of recess designs such as those illustrated in Figure 10.

Cylindrical or tubular joints have limited contact area unless heavy wall thicknesses are involved. Machining can provide adequate area for bonding. At the same time, the strength of the joint can be improved substantially by proper design. Figure 11 illustrates some of the approaches that have been made to improve strength in joints of this type.

Adequate clearance for adhesive must be allowed. Although pressure during bonding may be applied by compression from the ends, radial pressure is not practical. Therefore, high solids content, gap filling adhesives may be required with some designs.

Rigid Plastics

The design of joints for rigid plastics follows the same practice important for metals. Although some of the reinforced plastics of phenolic, polyester, and silicone resins have strength comparable to metal, they are often anisotropic. The strength properties are directional and the direction of load application becomes important. Anisotropic sheets should, of course, be oriented to obtain maximum strength properties.

In addition, some of the plastics tend to delaminate through separation of one ply from the next under peeling stress at relatively low loads. Such a property needs to be considered in the design of joints with laminates made from resins which do not adhere well to the reinforcing fiber. Some of the joints illustrated in Figure 5 such as the plain lap and joggle lap joints, would be more susceptible to delamination failure under tension (with the adhesive in shear) than a scarf joint or a beveled lap joint. The double strap joint would also be useful for minimum peel stress in tension, and would be good in compression as well.

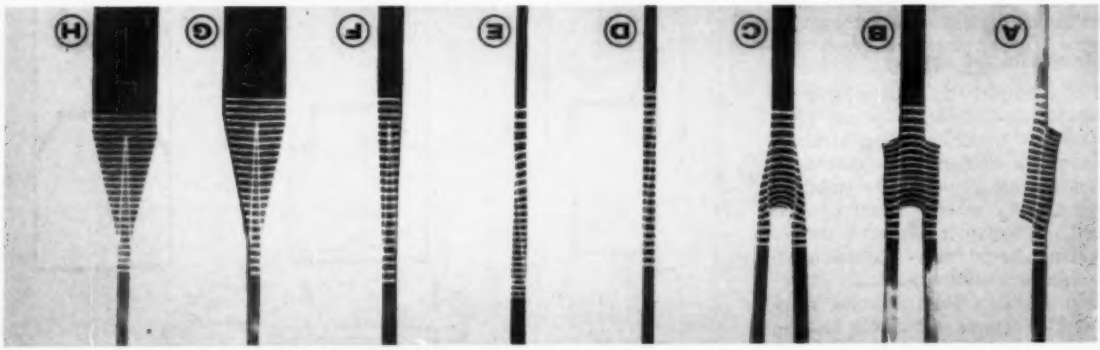
Rigid laminates with high delamination strength and resistance to peel may be bonded with joints of the types described for metal.

Laminates with unequal moduli, or laminates to be bonded to other materials, may be bonded with efficiency if thicknesses of material are used in an inverse ratio to the moduli, or if scarfs tapered according to the moduli are used. These considerations are important for high strength bonds with laminates. Many assemblies not involving any particular stress in service or residual stress from bonding, can be bonded with non-structural adhesives. Usually, such joints may be any of the types previously described.

Transparent plastics are often bonded with solvent or monomers which through fusion and solution with the plastic, or polymerization, result in bonds as strong as the plastic itself. Butt joints in flat sheets or on curved surfaces and right angle butt joints have been successful, but it is good practice to design such joints to hold the stress on the bond to a minimum.

Plastic laminates are also commonly bonded to plywood in sheet form. To maintain a sheet flat under

Figure 12—Stress Distribution in Scarf Joints and Other Types of Joints



Notes: A is a single lap joint. B and C are double lap and double lap taper joints of material of equal modulus. D is a scarf lap joint. E and F are scarf lap and double scarf lap joints of material of unequal modulus. G and H are double scarf lap joints of material tapered in proportion to modulus-elasticity.

a range of temperature and humidity conditions, it is necessary to balance the construction by bonding a plastic sheet to the back of plywood as well as the face. The design of sandwich construction with plastic laminate skins over a variety of core materials is not a part of this discussion.

Flexible Materials

Thin rubber or plastic sheets which cannot be heat sealed may be edge joined by a simple lap joint, or may be butted and a strap or doubler of the same material or of cloth applied over the seam. The butting of thin sheets is not practical, as butt joints in tension usually have inadequate strength. Scarf joints have been found to be most practical. The same holds true for strips of rubber in thickness ranges of 5/16" to 3/8" or heavier.

This also applies to assemblies which require splicing or fastening to form corners. Gasket assemblies are an example of such. The length of a scarf joint in rubber should be at least four times the thickness. In some instances, longer scarf joints are required.

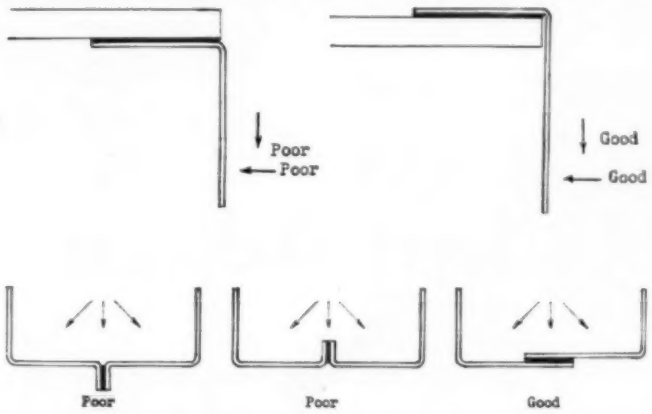
Figure 12 contrasts the uniformity of stress distribution in scarf joints with other types of joints. They also illustrate the uniformity of stress obtained with materials of unequal moduli by tapering the material symmetrically over the length of the joint in proportion to the moduli.

Adhesives used for bonding rubber vary widely from soft, rubber, tacky products to rather hard, rigid, thermosetting resins. Although the rubbery adhesives have good peel properties generally, the joints should be designed in shear rather than in peel where possible. This applies also to flexible plastic sheets.

Figure 13 illustrates plastic or rubber sheets bonded to metal in shear and peel and flexible plastic bonded to itself. In assembling sheets of thin gauge flexible composition to metal, particularly when bonded behind the metal to place the adhesive in shear, the overlap should be adequate to place a minimum unit stress on the adhesive. Tension in the sheet during assembly should be at a minimum, as this can result in residual constant stress on the adhesive.

Motor mountings and roll coverings involve the adhesion of heavier sections of rubber to metal. The basic considerations of minimizing the stress in the adhesive, designing for loads within the capacity of the assembly, and elimination of stress concentrations apply to these assemblies as well as other types that have been discussed. The size and shape of a roll, and thickness of rubber, usually are determined by the end use.

Figure 13—Plastic Sheets Bonded to Rubber in Sheer or Peel



Often, changes in design are not possible to permit most efficient functioning of the adhesive. Under severe loading with rubber roll coverings, which allow stress to be translated through the rubber to the adhesive, failures may be minimized by improving stress distribution in the rubber adjacent to the adhesive bond by increasing the hardness of the rubber at the inner diameter. Stress concentrations also should be minimized in rubber mountings through the elimination of sharp corners, or elimination of inserts in the rubber which could be fastened to the metal. The metal should be thick enough to prevent peel stresses, which may occur with thin gauge metals.

Sharp changes in sections of the rubber can also result in stress concentration. Loading over the capacity of the rubber-metal assembly can result not only in adhesive failures, but also in short life of assembly due to rubber fatigue and failure. Depending on the permissible cost and the performance requirements, it may be possible to eliminate overstressing in some applications by providing a compression bumper which comes into play when a given deflection is reached.

Rubber to metal assemblies in shear or tension loading may be designed at about 50 psi, and in compression at about 250 psi. These loadings, however, depend to a great extent on the application involved, the type of rubber, etc. Greater stability in such assemblies results when the ratio of bond area to free area of rubber is highest. Shear loading generally provides more stability than either tensile or compression loading does.

About the Author . . .

A. J. SLOSSER is general manager, Industrial Adhesive Sales, Industrial Division, Armstrong Cork Co. He has more than 35 years of experience in the field and was vice president of Goroco Products Co. before the firm was acquired by Armstrong in 1938. He received his present assignment in the company in 1946 as serving in various coating operations at the company.

Modern Adhesive Blending

Pre-testing is recommended as the only reliable guide to proper mixing and blending of solids and liquids

By JOHN J. FISCHER
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Patterson-Kelley Co., Inc.
East Stroudsburg, Penna.

Modern adhesives can present some highly complicated blending problems. Even the basic types can be difficult unless the modern blending methods or equipment designed to increase economy and production are correctly used.

Blending techniques and equipment have changed considerably in the last five or ten years—especially in the field of liquid-solids blending. New and radically different equipment has introduced wholly new concepts and modified old processes. The results, like all change, naturally produced some controversy. For instance, some people still consider blending an art while others insist that it must be approached from a scientific foundation.

Unfortunately, there is no positive scientific way of predicting the results of difficult-to-blend materials. Any generalized testing of various types of blenders—with the objective of classifying them as best, good or poor—is unsafe as a guide. There can be no real scientific approach until all of the factors that affect solids blending are thoroughly investigated and understood.

The immediate practical approach is to make use of accumulated test data and experience to help select the type of blending equipment which has the best possibility of success. The most reliable guide at present is specific testing under rigid conditions which control—to the highest possible degree of accuracy—all those variables affecting the desired results in the blended formulation.

Importance of Pre-Testing

The importance of pre-testing can be illustrated by an example of a mastic formulation which involved blending nine solids and two liquids. With multi-component blends, the blending equipment may be a secondary consideration to the procedure used to combine solids and liquids. In working out procedures, engineers and chemists tried various methods until they found that three of the solids were highly absorptive. To accomplish a highly satisfactory blend, the three solids were added last so they could not soak up the liquid in dispersion.

Pre-testing, then, has become an important factor in the design and manufacture of blending equipment and in determining proper blending procedures. A pioneer in the development and manufacture of blending equipment for process industries, the Patterson-Kelley Company, Inc., has tested hundreds of various blending formulations at its Pre-Test Laboratory in East Stroudsburg, Pa. Here, laboratory engineers and chemists develop proper blending proportions, procedures, and timing for many different products ranging from mastics to prepared biscuit mixes—all worked out to specific formulas submitted by the prospective user of the company's blenders.

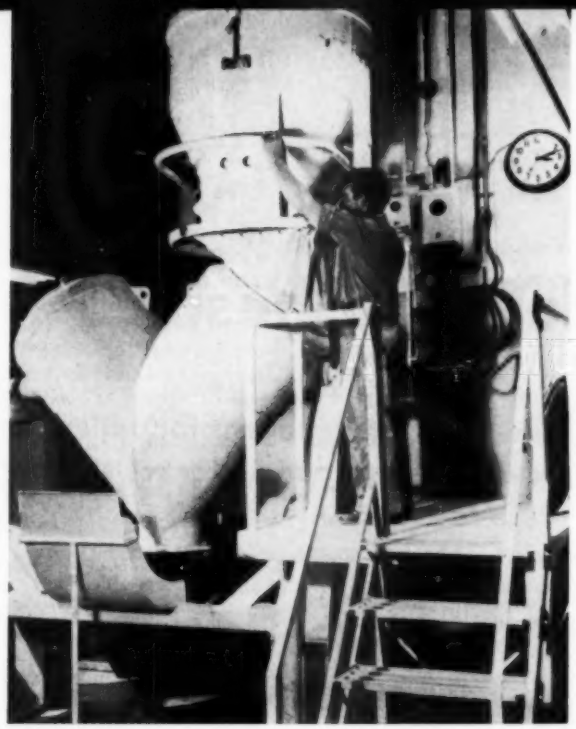
Since this pre-testing is conducted on a prospective basis, some products that have never "seen the light of day" have existed for a short time in the Pre-Test Laboratory. However, most formulations or products submitted for pre-testing have succeeded and are now being marketed.

Pre-testing may be conducted under the direct supervision of the user's representatives, or by P-K engineers alone. In either case, when tests are completed, a full report of test materials and methods, plus analysis, is sent to the user.

In pre-testing blending formulations, the company uses one of several different types of blenders. These include the Twin-Shell dry solids blender, considered a "radically new" type of blender when introduced in 1949, or the Liquid-Solids blender.

About the Author . . .

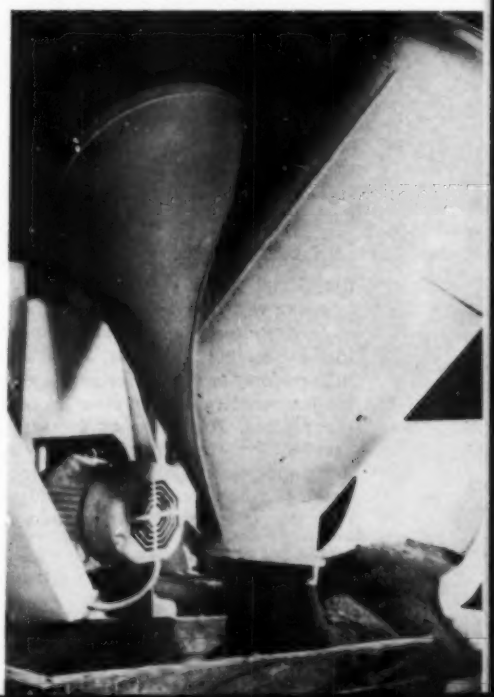
J. J. FISCHER has been chief engineer of Patterson-Kelley for the past 13 years. He holds numerous patents for improvements in solids blending and processing equipment.



The hopper is positioned over the Liquid-Solids unit and a canvas dust-protector is secured during charging.

After a specified pre-mixing, the blender operator opens the valve which supplies liquid to a feed bar in the unit.

A running discharge of the blended material after the liquids and dry materials are given an additional post-mix.



Basically, the Twin-Shell blender consists of two cylinders cut at right angles and joined to form a V-shaped design. Based on a centuries-old mixing method, the fundamental Twin-Shell mixing principle involves a combined tumbling or rolling action with a simultaneous transverse movement within the entire mass of material. In addition, a folding action is created by the combining and dividing of the mass during rotation. Results obtained in the laboratory blenders can be duplicated in production size blenders available in capacities up to 500 cubic feet.

Following this development, P-K engineers designed the Liquid-Solids blender. Essentially an all-purpose blender for plain tumbling, dry mixing, and liquid-feeding into solids, this type of blender keeps the dry solids in fine suspension, and in rapid motion, while they are sprayed by a finely dispersed liquid. This is accomplished by a hollow cylindrical bar running across the axis of the shell.

The liquid feed bar is removable and is driven through the hollow trunions by a separate motor drive. Revolving distributing discs on the feed bar, by centrifugal force, provide controlled liquid dispersion. Liquid feeding is accomplished by a stationary tube, either by gravity or, with high viscosity fluids, by a pump.

The principle of liquid dispersion into solids is quite flexible, and the degree of dispersion can be regulated by modifying either the rotational speed of the dispersion discs or the rate of liquid feed. Increasing the speed of rotation and reducing the feeding rate produces fine dispersion, and the reverse procedure is used to coarsen the dispersion. For any specific application, the speed of rotation is constant and granulation or fineness of dispersion is controlled by the rate of liquid feed.

This controlled liquid dispersion can produce a coarse spray for granulations or an extremely fine "fog" or mist for lump-free formulations. To date, more than 25 different versions of the liquid feed bar have been designed to meet various requirements of different formulations.

Mixing Multi-Components

Multi-component dry adhesives (mixed with liquid prior to use) requiring intimate dispersion of small quantities of liquid can be effectively blended by this method. The precise dispersion of liquids, as well as even blending of solids, affords the adhesives manufacturer an opportunity to gradually determine the order of adding blend materials and the time required to obtain effective finished formulations. Pre-testing by any means, is still the best guide to proper blending procedures.

Zinc Oxide in Adhesives

Though primarily utilized as a reinforcing agent for adhesive films, zinc oxide will improve both age and water resistance

By H. BALDYGA and H. C. JONES
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Recent demands for better adhesive materials have stimulated technical development and the result has been a spectacular growth of the industry. One of the essential ingredients in many important adhesive compositions is zinc oxide. Its use serves a variety of purposes such as improvement of cohesive strength, water resistance, and age resistance. Zinc oxide also neutralizes acidic decomposition products and modifies the properties of the adhesive in one way or another by the formation of zinc soaps.

Modern theories of adhesion stress the importance of polar molecules in developing initial wetting properties and attaining the best adherence, and the formation of zinc soap would certainly be in the right direction for optimum bonding properties. As there are widely diversified adhesive applications, so there are numerous types of adhesives which include zinc oxide in their composition. This article will be devoted primarily to the manner in which zinc oxide is understood to function in rubber base adhesives of the pressure-sensitive and related types. The several grades of zinc oxide available and the specific effects they impart to the adhesive will also be discussed.

Zinc oxide serves several purposes in a rubber base adhesive. Primarily it functions as a reinforcing agent for the adhesive film. In other words, the pigment reinforces or increases the cohesive strength of the film in a manner similar to the reinforcement of vulcanized rubber by a pigmenting agent. This is demonstrated by the fact that a finer particle size zinc oxide will produce a higher cohesive strength film than a coarser particle size zinc oxide.

There is also some evidence that the tack properties tend in the opposite direction and that as the cohesive strength increases with finer particle size zinc oxide, there is a loss in initial tack. These observations parallel the performance of tackifying resins in natural rubber and neoprene cements.*

Developing Cohesive Strength

The best cohesive or bonding strength is developed with the adhesive having the lowest tack. As the melting point of the resin is lowered and tack is improved, the cohesive strength of the film is impaired. This seems to be a more or less general rule for the behavior of rubber-resin adhesive systems.

Natural rubber has inherently good cohesive strength but this property is further enhanced by zinc oxide which also serves to improve the shelf life of the adhesive film. Natural rubber also has excellent tack but this property is modified by the addition of tackifying resins. In fact a wide range of adhesive and cohesive properties can be developed by the selection of the proper resin.

The reinforcing properties of zinc oxide are manifest in another form. The pigment stiffens the plastic mass and thereby reduces cold flow. Where it is advantageous to have a heavier adhesive film, as for example in a felt chiropodist pad, a higher concentration of zinc oxide reduces the flow to the adhesive film without impairing adherence.

Reference has freqeuntly been made to zinc oxide as a "wet" pigment, meaning that it contributes to the tackiness of uncured rubber. This effect, of course, is not so great as occurs with a resin addition to rubber. The unusual feature of zinc oxide, however, is that it not only promotes tack but also reinforces the adhesive mass by reducing the flow properties of the adhesive film.

Conversely, carbon black, whitings and clay tend to have a drying action on natural rubber and reduce the tackiness of the rubber compound. The latter materials are referred to as "drying" pigments and therefore have limited application insofar as their adhesive characteristics are concerned. A good example, outside the adhesive industry, is that of the construction of a tire. Zinc oxide improves the building tack and greatly assists in holding the parts of the tire together during assembly. Furthermore, the mild softening action of zinc oxide aids in fusion and union of the component parts of the tire during the curing process.

Why zinc oxide contributes to the tackiness of a rubber compound is not clearly understood. It probably in some way relates to the formation of zinc soaps with the tackifying resins. Present theories of adhesion emphasize the importance of polarity in the functioning of an adhesive. Certainly the formation of zinc resinates would greatly increase the amount of polar material in the adhesive mass. On the other hand, rosin esters which are effectively utilized in adhesive compounds would tend to reduce the amount of zinc soaps formed.

*Hercules Powder Company Bulletin, "Resins for Adhesives"

Conceivably the nature of the zinc soaps formed in the adhesive could have much to do with storage stability or shelf life. A hydrated zinc soap would have better tack retention properties than a zinc soap having little or no hydration. In other words, a soft hydrated zinc resinate might be expected to have humectant properties which would prevent premature drying of the adhesive mass. It seems very probable that a hydrated zinc soap would be the product resulting from the zinc oxide rosin acid reaction because the water formed from this reaction would be retained, at least in part, in the adhesive composition.

Distribution of molecular sizes has an important bearing on adhesion and a range of molecular sizes should give the best properties. The large molecules contribute to better film strength while the small molecules are beneficial to specific wetting and tack properties. Zinc resinates of varying molecular sizes would be desirable constituents from the standpoint of high polarity and distribution of molecular sizes.

Methods of Manufacture

Zinc oxide is produced by American and French Process methods of manufacture. In the American Process, the oxide is made directly from zinc ore and coal and in the pyrometallurgical operation the coal serves as both the fuel and the chemical reducing agent. French Process zinc oxide is made by burning a high purity zinc metal under controlled furnacing conditions. The several grades of zinc oxide and their properties are recorded in Table I.

Pressure-sensitive tapes are compounded both with American and French Process zinc oxides and it seems to be a matter of individual preference, or the specific requirements of the article in question. Most surgical tapes, for instance, are formulated with French Process zinc oxide because of the pharmaceutical limitations, notably the low lead content placed on this item. Electrical tapes might also be compounded with French Process oxides since the low water soluble salts contents of these grades would be a prerequisite for the best electrical performance.

The coarser grades of zinc oxide are usually preferred to the finer grades because of the more desirable initial tack and processing properties of the former. The high recovery characteristics of fine particle size oxides in compositions of this type militate against the formation of a smooth calendered sheet and retention of the gage of the film. The coarser oxides also perform better under a spreader blade for the same reason.

Table I—Typical Physical and Chemical Properties of Zinc Oxides

Brand	*Total Pb As PbO Per Cent*	*Total S As SO_3 Per Cent*	*H_2O Soluble Salts Per Cent*	*Acidity As SO_3 Per Cent*	*Surface Area (Sq. M/Gm)*	*Average Particle Size (Microns)*
American Process						
XX-4	0.08	0.25	0.60	0.25	4	0.27
Protox-166	0.08	0.25	*	*	4	0.27
XX-178	0.08	0.03	*	*	4	0.27
Special-3	0.08	0.25	0.60	0.25	4	0.27
XX-203	0.08	0.25	0.60	0.25	4	0.27
French Process						
XX-78	0.002	0.01	0.06	0.01	3.5	0.30
Kadox-15	0.002	0.01	0.06	0.01	10.0	0.11
Kadox-72	0.002	0.01	0.06	0.01	6.0	0.13

*Determination not feasible due to surface treatment

The rheological properties of the several types of zinc oxide in rubber are exemplified by the Mooney viscosity measurements recorded in Table II. In the Mooney viscosity test, the rubber mass is subjected to shear developed by a rotating disc in a cylindrical chamber. The viscosity measurement is the force required to rotate the disc in the viscous rubber mass at 212°F. The mechanism is equipped with a clutch which can be released and the elastic memory, "come-back," or recovery of the compound is measured. Both viscosity and recovery values are significantly related to the processing behavior of the adhesive in calendering and spreading operations.

Examination of the Mooney viscosity data shows that the fine particle size French Process oxide Kadox-15 imparts a higher viscosity and recovery than the coarser oxides. This behavior can be explained by the fact that as the particle size is reduced the mutual attraction between the oxide particles becomes greater, hence a greater stiffening or reinforcing effect. The recovery figure is even more dramatic.

Another explanation relates to the bound rubber concept. In this mechanism a tightly bound layer of rubber surrounds each pigment particle. It can be visualized that as the pigment surface increases, the volume of bound rubber and hence the viscosity of the rubber matrix becomes greater. These results illustrate why the coarser oxides have better processing properties than the fine oxides when the pigmentation level is high. The rubber stocks in this series were compounded with equal parts by weight of smoked sheet rubber and zinc oxide. Including rosin in the composition would complicate processing without adding any information to the experiment.

American Process oxides have a wider usage than French Process oxides in pressure-sensitive tapes other than the surgical type. This stems from the observation that American Process oxides generally impart better shelf life than oxides made from zinc metal. It should be emphasized, however, that this is only a general statement and, depending upon the adhesive composition, the shelf life provided by French Process oxide may compare favorably with that of American Process oxide.

This characteristic of the American Process oxide is thought to be associated with the basic zinc sulfates

Table II—Mooney Viscosity Measurements (ML-212°F.)

	Dial Reading (2 Minutes)	*Elastic Recovery (2 Minutes)*
XX-4	48	158
Protox-166	47.5	130
XX-178	46.5	144
XX-78	48	135
Kadox-15	53	190

Note: The rubber stocks in this series were compounded with 100 parts by weight smoked sheets and 100 parts by weight zinc oxide.

present in this type of oxide which retain moisture in the adhesive composition and thereby delay the drying out and loss of tack during shelf storage. The sulfate sulfur content (0.2 to 0.25 per cent) of this oxide originates from the sulfur in the coal. This is carried over in the gas stream and condenses on the oxide. In the presence of zinc oxide, the basic zinc salt is formed.

American Process oxides have a wide distribution of particle sizes, including a fine colloidal fraction and a range of sizes of greater particle dimensions. In this blend of sizes the advantages of both coarse and fines can be realized. The fine fraction contributes to better cohesive strength of the film and the coarse sizes impart better tack properties.

Surface Treated Types

Surface-treated zinc oxides of the Protox type, that is, treated with propionic acid, are employed in some pressure sensitive tapes. This short-chain organic acid, which is present as an oriented zinc propionate coating on the oxide, aids in the dispersion of the pigment without a degradation in adherence. The longer-chain fatty acids, such as lauric, stearic and oleic acids, however, have an adverse effect on tack and adhesion properties. Protox-166 would therefore be recommended for these applications in preference to an oxide surface-treated with a longer-chain fatty acid.

In referring to zinc oxide as the reinforcing agent in adhesives, it is not implied that this pigment is the sole means of reinforcement. Actually the rubber, resin and zinc oxide all function together in providing cohesive strength to the adhesive mass. The quality of the rubber and the degree of breakdown are the dominant factors influencing the inherent strength of the crude rubber. Properties of the resin, such as melting point have an important bearing on the cohesion of the compound.

The zinc oxide particle size and pigment loading are the features which determine the extent of pigment reinforcement. The strength of the adhesive mass can best be observed by slowly stripping a pressure sensitive tape from the roll. As the adhesive pulls away from the backing, fibrous threads are formed. Usually the short threads, or "legs" as they are sometimes called, denote a high cohesive strength while long "legs" or breakdown within the film are evidence of low cohesive strength. It is a balance of cohesion and adhesion that gives the best pressure sensitive tape.

Several typical pressure-sensitive adhesive compositions will be found in the patent literature given in these pages.

Aside from the adhesives based on rubber, zinc oxide is compounded in casein, casein-urea and epoxy-resin adhesives for improved water resistance. Zinc oxide speeds up the setting time of casein glues. The moisture resistance of sodium silicate adhesives is improved by the use of zinc oxide.

Glue can be prepared more quickly by replacing the conventional lime bath with a dilute alka-

U.S. Patent No. 2,206,899

Crepe rubber	100 parts
Zinc Oxide	100 parts
Rosin	100 parts
Heptane	400 to 600 parts

U.S. Patent No. 2,416,925

Crepe rubber	30 parts
Polypale resin	28 parts
Zinc oxide	20 to 25 parts
Mineral oil	4 to 5 parts
Starch	7 to 8 parts

U.S. Patent No. 2,451,865

Polyisobutylene of 100,000 molecular weight	24.8 parts
Factice	6.2 parts
Zinc oxide	27.9 parts
Dehydroabietic acid	30.9 parts
Beeswax	0.3 parts
White mineral oil	4.3 parts
Lanolin	3.1 parts
Polyisobutylene of 10,000 molecular weight	2.5 parts

U.S. Patent No. 2,498,338

Polyisobutylene 60,000 to 120,000 molecular weight	12.5 parts
Factice	25 parts
Hydrogenated glycerol abietate	10.5 parts
Zinc oxide	27 parts
Mineral oil	25 parts

U.S. Patent No. 2,559,990

Butadiene styrene copolymer	100 parts
Zinc oxide	5 parts
Titanium dioxide	10 parts
Yellow Pigment	0.3 parts
Oil soluble heat reactive phenol aldehyde resin	12 parts
Ester gum	40 parts
Paraffin oil	25 parts
Soft coumarone indene resin	40 parts
Heptane	300 parts
Alcohol	10 parts

U.S. Patent No. 2,511,600

Butyl rubber	37.5 parts
Zinc oxide	37.5 parts
Nevillite No. 123 resin	12.5 parts
Circo light oil	12.5 parts
P-quinone dioxime	0.8 parts
T-butyl hydroperoxide	1.5 parts

About the Authors . . .

H. C. JONES is in charge of New Jersey Zinc Co.'s Rubber and Plastics Lab. He received his M.S. in chemistry from Lehigh University in 1928.

HENRY BALDYGA is a research investigator in the Rubber and Plastics Lab. In 1950, he received his M.S. from Holy Cross College, Worcester, Mass.

line solution containing zinc oxide. Acids formed as a result of the decomposition of glue tend to accelerate the deterioration unless neutralized by a metallic oxide such as zinc oxide.

Caulking compounds and sealants may be classed as adhesives since their commercial usage is dependent upon adhesive properties. The gasket-like sealant on most canned-food containers is a rubber base composition with a substantial loading of zinc oxide.

In summary, zinc oxide is a versatile material and contributes a number of essential properties of rubber-based pressure sensitive adhesive compositions. Zinc oxide improves the cohesive strength and enhances the tackifying properties of an adhesive mass. Furthermore, the initial tack or wetting characteristics of the adhesive is favorably influenced by the zinc soaps formed from the zinc oxide-resin reaction. The shelf life or storage stability of pressure-sensitive adhesives is materially extended by the presence of zinc oxide.

Epoxies Tailored to Fit

Adhesive manufacturer offers users a custom formulating service designed to insure maximum bonding efficiency

An adhesive formulator recently received phone calls from two clients who wanted "an epoxy adhesive." Both were a little puzzled when the manufacturer suggested that it might be best if he sent a member of his technical service engineering staff out to their plants before submitting any samples.

"Sure, if you want to," said one client, "but all we need is some of this epoxy."

The adhesive technician reported back that an epoxy was indeed what they needed, but that the same formulation would hardly have given both of them efficient solutions to their bonding problems.

Company A wanted to bond vinyl to bakelite. They needed a fast hardening, room temperature curing system. Because they would be using unskilled labor, no complicated weighing and mixing could be done at the plant.

At company B, the problem was one of bonding aluminum to aluminum. In this case the requirements were for a flexible, room temperature curing resin with a pot life of over an hour. In addition, the cured resin would have to have the appearance of aluminum.

The two cases cited above are examples of some of the problems being handled by Resin Consultants & Mfg. Co., Inc., New York, N. Y., under their new custom formulation setup. With the increasing trend toward switching from mechanical fasteners to adhesives on the production line, RCM decided that the new service could make available to each client an adhesive system which meets his specific needs, rather than a stock adhesive that would only partially satisfy user requirements.

Here's how the setup worked with manufacturers A and B.

The technical service engineer noted each company's requirements and forwarded them to the RCM laboratory staff for suggestions. Individual resin systems were formulated to meet the specific production needs, and tests run on specimen bonds. The next time the technical service engineer visited the client, he had with him the finished product and an evaluation sample.

To company A went a pre-weighed, proportioned kit consisting of a modified epoxy resin and hardener. All that's required on the production line is pour the hardener into the resin, stir and apply. The pot life of the adhesive is 15 minutes, ideal for the high production rate. Curing is accomplished in four hours at room temperature.

Company B got a thixotropic, aluminum-filled epoxy system that afforded the desired bonding flexibility. The pot life of the resin is 75 minutes and it cures overnight at room temperature. The RCM representative helped the client set up mixing and application techniques best suited to his production line setup.

With the large number of epoxy resin formulations available, RCM executives point out, it is impossible to find one system that meets all requirements. Custom formulating and packaging is the only way to give the user *the* resin for his *specific* application.

What to look for in

Glues for Furniture Production

By ROBERT F. SNIDER
The Franklin Glue Company
Columbus, Ohio

When we admire a piece of wooden furniture, we seldom consider the part that glue plays in making it beautiful. Although a chair, desk or sofa may contain less than 50¢ worth of glue, its value as a thing of beauty would perish if the glue should suddenly disintegrate: a furniture item worth from $500 to $1000 would suddenly become mere firewood.

A little thought will show us that the design and the wood which we see and admire is to a great extent dependent upon the glue we cannot see.

In any piece of furniture, glue is used in many places and in many types of joints. For example, most wooden chairs have glued dowel joints at the end of the stretchers and rails connecting the legs. These rails also support the seat. If the chair has a wooden seat, it is probably made of narrow boards glued together. The all-important glue line, however, is indicated only by a discontinuity in grain direction.

Glue Use Increasing

Glue is used more extensively in contemporary furniture than it was in earlier designs. This is due to better glues and gluing methods, changing furniture designs, and the lack of adequate or economical supplies of large logs. Older furniture frequently used tight pegs or keyed pieces as fastenings.

Although chairs are being produced that require no glue, nails or screws as fastening devices, most wooden furniture is held together with an adhesive because gluing has proved to be the most desirable fastening method. It permits designs and patterns not possible with mechanical fittings alone.

However, wood gluing presents some more or less unique problems. For example, wood is a relatively strong material but it is heterogeneous and affected by moisture content. These three variable wood properties—strength, heterogeneity and moisture content—have to be considered in making a successful woodworking glue.

Because of the pores in wood, the heaviest of the common furniture materials such as sugar maple and pecan have a specific gravity of about 0.65. Cottonwood has a specific gravity of only 0.35. This means that only 43 per cent of a maple surface is actually wood—the rest is air. With the lighter cottonwood, there is only 23 per cent wood substance at the surface layer and 75 per cent is air and therefore nongluable.

In spite of the low proportion of wood substance, even in maple, a shear strength (in the direction of the grain) of 3500-4000 lbs per square inch of surface is not uncommon. It has a modulus of elasticity of greater than 1,830,000 psi. A force of over 1400 lbs is required to embed a 0.444 inch ball halfway into the side grain. These few figures give some indication of the strength of sugar maple, a wood commonly used in the manufacture of wood furniture.

One of the problems in utilizing wood is its hygroscopic nature. It acquires and releases moisture to remain in equilibrium with the relative humidity in the surrounding air. In the low humidity of a heated house in northern climates, the moisture content of wood is frequently reduced to four percent. In the summertime, this equilibrium moisture content may rise to 15 per cent.

When the moisture content of wood alters, it causes considerable dimensional change in a radial and tangential (related to annular rings) direction, but negligible changes in the direction of the grain.

This change does not occur evenly throughout the panel, but is faster at the exposed endgrain than at the face grain which is some distance from the end of the panel. In addition, if there is a piece of radial grain beech glued next to a piece of tangential grain beech, in a 4x4 top, one of the pieces will become 1/50" thicker than the other one.

Both these dimensional changes impose heavy, longtime stress on the wood and glue. This may be so great as to cause failure or checking in the wood. Checking indicates that the wood stresses have exceeded the wood strength. These stresses are intensified at the glue lines, since the glue lines are surfaces of maximum heterogeneity. This is one of the reasons why a wood glue has to provide a strong bond under widely varying circumstances.

Exterior Conditions

Additional severe exposure conditions are the alternate soaking and drying which items such as a boat or the exterior door of a house undergo. The aggravated stress conditions here would require adhesives of high water resistance.

Another difficult hurdle which a woodworking glue must clear is that of exposure to elevated temperatures. In some woodworking plants, the ovens used to bake on the finish may reach 140°-150°F. At this temperature, the glue line must not only bear the stress due to the elevated heat, but also the stress caused by the changing moisture content in the wood. It is important that with these unusual stresses the glue does not soften and weaken.

High temperature exposure conditions also occur when, for example,

furniture is exhibited in a show window or travels through the desert in a closed boxcar.

Operation methods of the furniture industry make additional demands on woodworking glues. From this point of view, among the properties desired of the liquid glue are:

(1) A viscosity that lends itself to spreading the glue by conventional methods.

(2) Gap filling to compensate for inaccurate machining and dimensional changes which may occur between making the joint and gluing it.

(3) Suitable speed of set and assembly time to accomodate widely varying operating conditions. In some operations, such as rubbing in corner blocks, an almost immediate grab is required. In many assembly operations, clamping times of about a minute are used. For cold edge gluing, clamping times of 45 minutes to an hour should result in glue strengths 50 per cent higher than the wood, to allow removal from the clamps at this time.

Laying-Up Time

In some operations, practically no assembly time is required. For other applications, such as the laying-up in the cold of large panels, the glue should not set up for as long as 45 minutes, at which time pressure is applied.

Where the glue is set by high-frequency, parts may only be clamped for a few seconds. Glue for an operation of this type has to be formulated so that it conducts adequately but not so excessively that it arcs and burns in the joint.

(4) Adequate wetting and penetration is necessary to get a good bond. However, if penetration is excessive, after the superfluous glue has been squeezed out by clamping, an inadequate amount of glue is left in the joint. The result is what is known as a "starved" joint.

(5) Ease of use with the conditions of temperature and unskilled manpower available is a must.

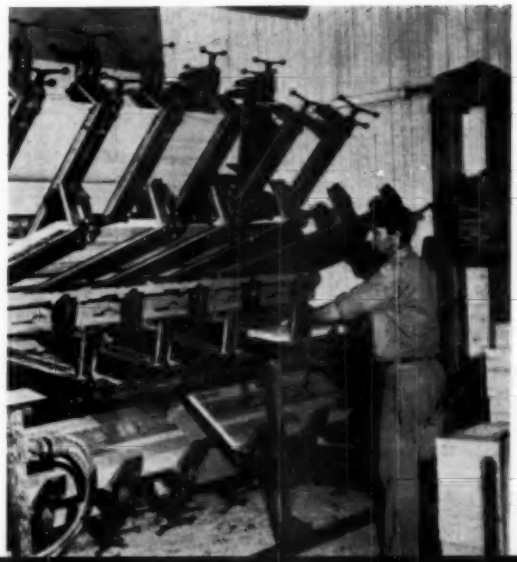
(6) Unlimited working life.

(7) Simple preparation requiring no complicated weighing and mixing of ingredients.

In addition to the above requirements for liquid glues, there are several properties which are musts for the dried glue film. The latter must have resistance to swelling in the solvents used for finishes and resistance to sandpaper "loading." There should be minimum run-down of squeeze-out and easy squeeze-out

In this type of spreader for box sides, the spoked wheel turns in the glue. The dovetail on the box side runs in the glue-covered spokes.

A roller spreader is a common means of gluing long pieces of wood. Some units have hoods over the roller to inhibit solvent evaporation.



A carrier unit for clamping long panels. Glue is used even more extensively in contemporary furniture than it was previously.

cleaning. Finally, it must be easy to detect misplaced glue before the finish is applied to the wood surface.

Though a glue may meet all these requirements, it is valueless unless it supplies a glued joint capable of durability in service.

No glue has been devised to meet all the requirements listed above. However, because of their uniformity and versatility, the newer woodworking glues are easier to use and give better results under plant conditions than did the glues of thirty years ago. As a result, they are rapidly superseding archaic glues and gluing techniques of the past.

As new and more versatile glues are developed to meet specialized requirements, production speeds or lower costs, it has become the responsibility of the glue manufacturer and his technically trained salesmen to recommend the best glues for a particular application. Almost all woodworking glues used today will pass the simple chisel test or hammering over a corner post. However, they may not stand up under the many and varied conditions of use.

The extensive experience and scientific knowledge possessed by the reputable wood glue manufacturer is readily available for the asking. As a matter of fact, the woodwork manufacturer who does not consult with his glue supplier about his gluing problems is missing an opportunity to operate as efficiently and effectively as his competitor. It isn't good business and it isn't good sense.

Today's intense competition makes the technical advice and counsel of an experienced glue engineer more important than ever. He can be of invaluable service in aiding the woodworking glue user to obtain not only the best glue, but the most efficient and economical use of it for each plant operation.

About the Author . . .

ROBERT F. SNIDER has been associated with the Franklin Glue Co. for 24 years. A major portion of his interest has been in the field of woodworking adhesives. He received his Bachelor's, Master's and Doctorate degrees from Ohio State University.

Epoxy-Bonded Speed Boat

Adhesive techniques contribute to the design of a new high speed hydroplane that may win the world record for America

The high adhesive quality, exceptional strength and moisture-proofing properties of epoxy resin are making important design contributions to the Miss Stars & Stripes, a revolutionary power boat built to serve as a floating high-speed research laboratory.

The 36-foot hydroplane is powered by two 12-cylinder Packard PT boat engines with 2000 horsepower each. Some of the unique features of the boat are its epoxy-laminated fiber glass and mahogany structural panels, high-speed design, and propellers and rudder of the most advanced type.

Two Applications

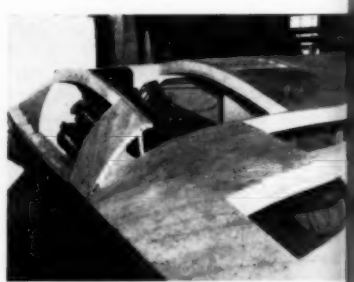
Epoxy resin is used for two important jobs: to bond a sandwich of glass fiber cloth between two mahogany veneers which form the craft's hull, and to coat the hull exterior to provide a tough, slick finish.

The laminated structural panels were produced by Haskelite Mfg. Co., Grand Rapids, Mich.

In construction, the interior mahogany veneer (some sections are 36 feet long) was put through an adhesive spreader which applied a 1/32-inch coat of Bakelite Epoxy ERL-2795 over the entire surface. Glass fiber cloth was then applied and smoothed. After the spreader had applied epoxy to the exterior veneer, the sandwich panels were placed in a cold press to set.

Miss Stars & Stripes is now undergoing intensive testing which is expected to aid in the design of easier, more efficient military and pleasure boats of all types. It may also help bring the world water speed record to America. The record is now held by England's Donald Campbell who clocked 260.35 mph.

The craft weighs 11,000 pounds in all, and each engine weighs 2300 pounds. It was built in Bay City, Mich., and is owned by Robert E. Evans, president of Haskelite and of the Precision Scientific Co., Chicago, Ill.

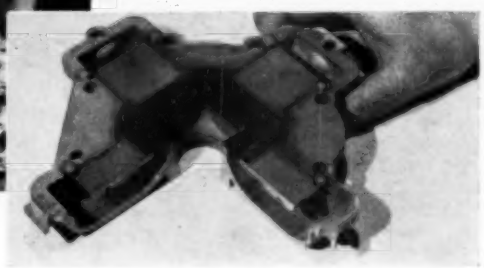


Construction photo shows epoxy-laminated fiber glass and mahogany section which provides the boats built-in strength.

The use of epoxy resin permitted a design that significantly contributes to the speed of the Miss Stars & Stripes hydroplane.

Note: Bakelite Epoxy ERL-2795 is manufactured by the Union Carbide Plastics Co., New York, N.Y.

Production line photo shows the adhesive being applied to the butt shoulder joint of a die cast section. Next, the flat x-shaped section will be put in place. The insert shows a cutaway section of the completed pump assembly.



Adhesive-Bonded Pump Assemblies

By bonding together three die-cast sections instead of molding the unit as one piece, a manufacturer is able to save $750 per run of 1000 complex pump assemblies

Complicated, difficult - to - make castings are now easily and economically produced by assembling simple cast sections with adhesives. According to one large pump manufacturer, the technique has made it possible to reduce the rejection rate of completed units from one in four to nothing.

In this application, three separate die castings are bonded together to form one complicated pump assembly. The adhesive used is a one-part, high-strength epoxy compound designated as EC-1386. It was developed by the Adhesives, Coatings & Sealers Division, Minnesota Mining & Manufacturing Co., St. Paul, Minn.

Previously the pump part was cast in one piece by the sand mold process. However, because of the complex interior design of the casting, blow holes often occurred and resulted in rejection rates as high as 25 per cent. On a run of 1000 castings, this amounted to a loss of more than $750.00.

Adhesive bonding of the three die-cast sections was selected as the method of assembly because of the many advantages it offered over other techniques. To begin with, it eliminated the need for lugs, bolt holes and flanges necessary with mechanical fastenings.

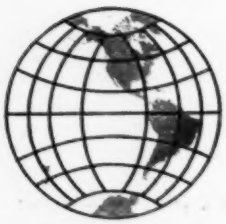
This savings in its turn obviated additional expensive and time-consuming machining operations. Since adhesives automatically seal the three die-cast sections at the time of bonding, the time and cost of separate sealing or gasketing operations are also eliminated.

Adhesive bonding does not require the high heat necessary for welding or brazing operations which may tend to distort castings. In addition, no corrosive fluxes are required with the adhesive method, so that costly neutralizing operations are bypassed.

By using adhesives to assemble the castings, the manufacturer may also take advantage of equally serviceable but less expensive casting materials. For example, to join sections of castings by welding or brazing, high-temperature resistant alloys must be used. This will generally limit the type of casting material that can be employed.

Because skilled labor is not required for bonding operations, production costs are substantially reduced. In addition, adhesive assembly methods are adaptable to both short run or continuous production methods.

The cost per part for adhesive assembly becomes negligible when compared to the rejection cost incurred with the previous method. Approximately one gallon of adhesive will assemble 1000 castings. This amounts to an adhesive cost of approximately 3.2 cents per part.



NEWS of the

ADHESIVES WORLD

Quantum Sponsors Informative Symposium on Adhesion and Adhesives

More than 200 adhesives users, suppliers and manufacturers attended the industrial symposium on "Adhesion and Adhesives in Industry" sponsored by Quantum, Inc., at the Yankee Silversmith Inn, Wallingford, Conn., on November 19, 1959. The interest in the meeting was such that C. M. Doede, president of Quantum, reported that more than 100 applications to attend the sessions had to be turned down.

Featured speakers at the meeting included Dr. J. J. Bikerman, Adhesives Research Laboratory, M.I.T.; E. Patrick McGuire, Packaging Adhesives and Specialty Products, Borden Chemical Co.; Dr. L. H. Perry, U B S Chemical Co.; J. J. Maher, Plastics Division, Reichhold Chemicals, Inc.; E. V. Huda, Raybestos-Manhattan, Inc.; D. D. Streed, U.S. Rubber Co.; and H. A. Perry, U.S. Naval Ordnance Laboratory. In addition, special presentations on adhesives were made by R. E. Russell, and P. M. LaFlamme of Quantum. D. W. Maher, Minnesota Mining & Manufacturing Co., was the featured speaker at a dinner that wound up the symposium.

In his talk entitled "Introduction to Adhesives," Dr. Bikerman presented information on a theory of adhesion which in many ways is a new departure in the field. "Molecular forces across the interface between an adherend and an adhesive never determine the strength of an adhesive joint," he explained. "This is so because in many instances no interface exists (as a result of intermixing or chemical reaction) and—if an exact interface is present—because the probability of rupture proceeding along this complicated path is very small."

Dr. Bikerman went on to add that if a joint seems to fail in adhesion, the presence of a weak boundary layer may be suspected. He took as an example commercial polyethylenes which do not adhere well to solids and to which printing ink does not adhere.

"This poor adhesiveness was believed to be due to the weakness of the molecular field of force around the polyethylene chain. However, when ingredients—low molecular hydrocarbons and oxygenated compounds—which are likely to form a weak boundary layer on polyethylene were removed, the resulting polyethylenes proved to be dependable adhesives; the breaking stress of butt joints made with them was greater than the breaking stress of the adhesive in bulk."

"Natural Adhesives" was the subject of the talk given by Mr. McGuire, who is technical service manager of Borden's Packaging Adhesives and Specialty Products. He divided natural adhesives into three main types: animal glue, casein and starch-dextrine.

Animal Glue Consumption

He pointed out that more than 105 million pounds of animal glue is consumed in the U.S. every year. Though one of the problems in the past has been the permanent plasticization of the glue films, he noted that new resinous plasticizers offer promise of a solution soon.

Mr. McGuire set American casein consumption per annum at 70-75 million pounds. "The total sales of natural adhesives to the packaging industry," he concluded, "is es-

Dr. C. M. Doede, president of Quantum, Inc., opens the symposium on "Adhesion and Adhesives in Industry." Right, facing the camera, is Dr. J. J. Bikerman, supervisor of the adhesives laboratory at the Department of Civil and Sanitary Engineering, M.I.T.

You can't buy adhesives from us, but we'll gladly refer you to some very fine people who supply adhesives made with our resins.

What can a pinch of permanence do for your adhesive formulation?

We don't know—but we'd like to help you find out.

For many adhesives producers, the pinch of permanence has led to striking advances in adhesives. It has opened the door to new applications, has helped leading formulators develop new markets.

For you, this pinch of permanence—the right phenolic resin—may well be the answer you seek to problems of film strength, tack, resistance to heat or moisture, flexibility or hardness, and many other qualities of the adhesive.

If you haven't looked into phenolics lately, you may be impressed when you do. A lot has happened in the past five years. At Durez, a lot is happening right now. New resins are coming out of the lab every week. One of them may be just what you need.

See an opportunity here? Let us help you take advantage of it. For more information on Durez resins for adhesives, just drop us a note outlining the properties you're after.

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pected to exceed $105,460,000 a year."

Dr. L. H. Perry's talk on "Rubber-Based Adhesives" was intended to provide a background for choosing the best adhesive for a particular application. "More often than not," Dr. Perry pointed out, "the user would find it helpful and cost saving to devote more time to a study of his problem before selecting his adhesive."

Principal rubbers or elastomers used in rubber-based adhesives are natural, reclaim, neoprene and nitrile, he noted, though some styrene rubbers are also being used. "The second most important ingredient of these adhesives are resins. If the rubber is the backbone of the adhesive, then the resin can be said to give the adhesive its character." The resin controls its tack, he said, improves adhesion to specific materials, increases strength and in many cases acts as part of the curing system.

Dr. Perry also explained that since rubber adhesives are characterized primarily by their tack, they should be considered whenever resilience is desired within the adhesive joint. He concluded by noting that in recent years isocyanates have shown excellent promise for improving adhesion of rubber-based adhesives to materials containing active hydrogens.

Resin-Based Adhesives

"Resin-Based Adhesives" was the subject of the address given by J. J. Maher. Resins for adhesives, he stated, are usually classified according to their reaction to thermal energy: thermoplastic materials soften and flow under heat, while thermosetting materials cure into infusible solids.

"The most common thermoplastic resins used in adhesives are the vinyls, the cellulosics and the acrylics. The most common thermosetting resins in adhesives are the phenolic, the urea and the melamine resins. Alkyd, urethane and epoxy resins are also used."

Mr. Maher broke down the sales of these materials for 1959 as follows:

Phenolics accounted for 50 per cent of the total market or over 200 million pounds; ureas and melamines accounted for 28 per cent or 120 million pounds; vinyls accounted for 19 per cent or 80 million pounds. Other resins made up the remaining three per cent for about 12 million pounds. The total volume of resin sales ranged from 120 to 150 million dollars.

Mr. Maher warned that to most effectively realize the growth potential in resin-based adhesives, the adhesive formulator must avoid overselling his wares as "miracle material." "Alternately," he went on, "the user must realize that the preparation and application of adhesives is a complex business involving both science and art. It will be through the efforts of an enlightened group of men, therefore, both at the adhesive manufacturers level and at the users level, that the growth of resin-based adhesives will continue."

Speaking on the topic of "Structural Adhesives," Mr. Huda, who is project supervisor of adhesives at Raybestos-Manhattan, described the bonding of friction materials to steel and molded cores. He pointed out that his company's entry into the process 20 years ago was a matter of necessity, as parts to be made at that time were too thin to be riveted.

Two types of adhesives are used for bonding friction materials: phenolic base and nitrile-phenolic base. The former is used on all assemblies where bond line temperature might exceed 400° F. in application for prolonged periods. Nitrile-phenolic-based adhesive is used where some flexibility is desired and where the bond line temperature will not exceed 400° F. for any prolonged period.

"The phenolic base," Mr. Huda stated, "although strong and showing little heat deterioration, is not recommended for use in metal-to-metal bonds because of its brittle nature. The fact that friction materials are somewhat porous or cellular in structure makes the phenolic adhesive excellent as a bonding agent."

Rubber Adhesion Problems

Assistant Technical Director of U.S. Rubber Co., D. D. Streed, spoke on "Adhesion Problems in the Rubber Industry." He pointed out that the rubber industry makes wide use of adhesives not only in conventional waterproof and canvas footwear, but also in coated fabrics, inflatable bags and containers of all kinds. Mr. Streed listed the following four fundamental requirements for a rubber to fabric adhesive:

(1) It must have sufficient tack to allow the part to be pulled apart and relined if necessary.

(2) It must have high green strength not only at room temperature but at 260° F.

(3) It must be easily flowable through conventional fabrication equipment.

(4) It should have a service life of 30 days at 90° F. and should dry to a tacky condition in not over 10 minutes at 120° F.

Among the needs of the rubber industry, Mr. Streed included an adhesive to permit wider use of the new oil extended synthetic and natural elastomers; a butyl adhesive for adhering uncured butyl to rubber, uncured butyl to butyl, and uncured butyl to fabrics. In addition, he cited a need for an adhesive to cement a highly plasticized vinyl to a cured or uncured rubber, as well as an adhesive for adhering cured rubber to cured rubber both of the synthetic and natural type.

Mr. Streed went on to outline several other industry needs and concluded: "Fundamentally, adhesives are urgently needed which can be used on a production line to make seams and joints as rapidly as sewing machines do today. A good working alliance between the rubber and plastic fabricators in the development of new materials and techniques will lead to a growth pattern which will be to the advantage and profit of both."

Classifying Adhesives

A special presentation on the "Classification and Description of Adhesives" was given by Robert E. Russell, Quantum staff scientist. He pointed out that adhesives could be classified by:

(1) The cure temperature required to obtain a good bond.

(2) The types of adherends they bond.

(3) The method by which the gel structure forms.

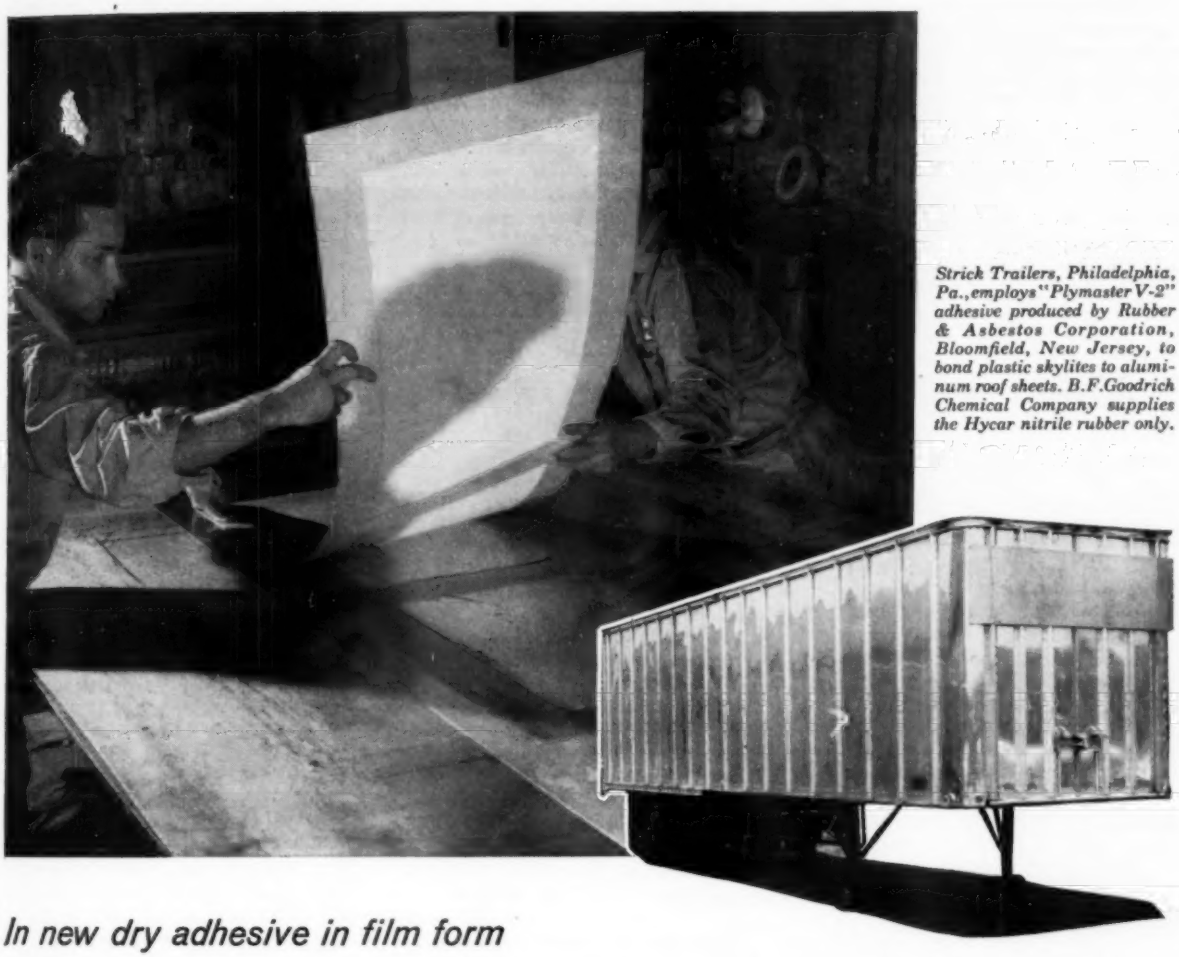
(4) Principal chemical ingredients in the formulation.

The chemical classification is the most widely used, he reported, because the general properties of the groups can be summarized and used as an aid to adhesive selection.

P. M. LaFlamme, associate project leader at Quantum, spoke on "Taking Maximum Advantage of Adhesives." He noted that often the possibility of using adhesives may be overlooked in spite of numerous advantages because of the novelty of the particular use. "In many cases, adhering can supplant conventional bonding methods with savings resulting from less machine work and a small number of rejects due to

Another new development using

B.F.Goodrich Chemical *raw materials*



Strick Trailers, Philadelphia, Pa., employs "Plymaster V-2" adhesive produced by Rubber & Asbestos Corporation, Bloomfield, New Jersey, to bond plastic skylites to aluminum roof sheets. B.F.Goodrich Chemical Company supplies the Hycar nitrile rubber only.

In new dry adhesive in film form

Hycar rubber speeds and simplifies bonding

Mass-production bonding of flat surfaces as unlike as plastic and aluminum demonstrates the efficiency of this new dry adhesive in film form. It uses Hycar nitrile rubber to produce a bond between plastic skylites and aluminum roof sheets on both trailers and truck bodies. The adhesive manufacturer says Hycar provides a higher combination of cohesion and adhesion strengths than any other copolymer tested.

The adhesive comes in rolls from which sheets can be cut to exact size. No need for expensive liquid-handling equipment. You get a much cleaner, faster operation. The film adhesive can be reactivated with common solvents, heat or pressure to achieve tensile strengths as high as 1500 psi.

The exceptional qualities of Hycar nitrile rubber have led to produce improvements in many fields. For more information, write Dept. KP-1, B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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faulty assembly. In other cases, adhesives, because of their unique properties, can be the means by which entirely new products can be produced." If an adhesive system and design is not available to meet particular manufacturing specifications, said Mr. LaFlamme, research can often turn up a time- and money-saving solution.

The featured speaker at the dinner which closed the symposium was D. W. Maher, merchandising manager of the Adhesives, Coatings & Sealers Division, Minnesota Mining & Mfg. Co. Speaking on "Future Trends in Adhesives," Mr. Maher drew attention to the fact that new adhesive products, new materials and unusual combinations of materials, and improved application techniques all point to increased use of adhesive bonding in industry.

He spotlighted trends in various industries and concluded that one of the big jobs ahead was educating the manufacturer to understand and accept new and better uses of adhesives.

ASTM Committee D-14 Meets in Cleveland

Two new subcommittee sections formed to handle special problems in shoes and optics

Two new subcommittee sections designed to handle special problems in adhesives for shoes and optics were established at the meeting of the ASTM's Committee D-14 on Adhesives, held at the Case Institute of Technology, Cleveland, Ohio, on November 5-6, 1959.

The section on shoe adhesives will be known as Section H of Subcommittee V. It will be headed by R. J. Carey of Compo Shoe Machinery, 125 Roberts Road, Waltham 54, Mass. Those interested in further information are invited to write to Mr. Carey.

The second new sub-section is designated as Section I of Subcommittee V and according to its chairman, Marco Petronio, will deal with "optical adhesives, including the bonding of optical elements such as are used in binoculars, telescopes and microscopes. It will also cover safety glass and plastic laminates where clarity and transparency are of prime importance." Those interested in joining the new section or obtaining more information are invited to write to Mr. Petronio at the Frankford Arsenal, Bridge & Tacony Sts., Philadelphia 37, Penna. Mr. Petronio is chairman of Subcommittee V.

Approximately 50 members from all over the country attended the D-14 sessions which were set up at Case Institute by John E. Rutzler, Jr., chairman of the ASTM Committee on Adhesives. According to figures released at the meeting, total membership of the D-14 Committee is 129. Of these, 48 are producers, 60 are consumers, and 21 members having a general interest in the field.

At the meeting of the D-14 Advisory Committee, a report was given by the Ad Hoc Committee for setting up regulations on an award for a paper on the fundamental aspects of adhesion. This award is sponsored by ADHESIVES AGE, and ASTM Committee D-14 is to designate the person whose recent work it would care to so honor.

It was agreed to designate the award as the "ASTM Adhesion Award." The award is to be made annually and the recipient will receive a bronze plaque containing his name, the ASTM Seal, a suitable inscription and the date the presentation was made.

The Advisory Committee also announced the following changes in the setup of D-14's 13 subcommittees. R. L. Patrick, Continental Can Co., Chicago, Ill., assumes the chairmanship of Subcommittee XI on Metal Bonding Adhesives. C. W. Bayley, Jr., Borden Chemical Co., Coatings and Adhesives Dept., Peabody, Mass., will head the recently formed Subcommittee XIII on Floor Tile Adhesives.

It was also announced that D. A. George, National Bureau of Standards, Washington, D. C., will represent D-14 on the ASTM's new Committee C-24 on Sealants.

After a discussion on a questionnaire from ASTM Headquarters as to the current use of the metric system in D-14 methods, the Advisory Committee adopted the metric system. It is to be gradually incorporated into D-14 methods. In the beginning, the equivalent method will always be given in the British system.

The next meeting of Committee D-14 will be held in Philadelphia early this spring.

Marco Petronio

Heads new section on Optical Adhesives of Subcommittee V.

R. J. Carey

Heads newly established section on Shoe Adhesives.

Houghton Names Murray

Houghton Laboratories, Inc., Olean, N. Y., has announced the appointment of David M. Murray as its treasurer. Mr. Murray is a graduate of Boston University and a certified public accountant. Prior to joining Houghton, he was with Boyden, Yardley and Guay, and Clark Brothers Division of Dresser Industries. Mr. Murray is a member of the American Management Association and the National Association of Accountants.

Becco Epoxy Process

Becco Chemical Division, Food Machinery & Chemical Corp., Buffalo, N.Y., has announced that its continuous 'epoxidation process is now ready for pilot scale development, and is being offered to the trade for refinement. According to the company, the process uses an unsaturated oil, an organic acid and hydrogen peroxide. These are introduced countercurrently into the top of a packed column and the resultant epoxidized product and spent reagents are removed continuously at the other end. Becco claims that when the process is scaled up to commercial size the advantages will be increased time-volume productivity, higher yields and greater purity than are obtained by conventional batch methods. Epoxidized products find applications as plasticizers and stabilizers for vinyl resins, resin intermediates, rubber modifiers, reactive diluents, acid scavengers, insecticides, textile finishes, and in protective coatings, the company states.

Shell Develops Coating

Shell Chemical Corp., Los Angeles, Calif., has announced the development of a new, low-cost Epon resin-bitumen coating. According to the company, the new coating is especially suited for use as an economical corrosion-resistant covering for pipe and other metal equipment and on concrete surfaces. Based on Epon 828 and Bitumen C, the new coating has greater chemical resistance than existing epoxy-coal tar enamels, the company claims. Because of its adhesive qualities, toughness, and resistance to water, it is also ideally suited for use on exterior concrete walls below ground level, roof coating, silos and hopper cars and other railroad rolling stock, the company states.

Board Test Established

The Technical Committee of the West Coast Adhesive Manufacturers has established a test method for the measurement of internal bond strength of composite wood boards. The test, designated Test Method No. 5.1, measures the internal strength of board perpendicular to the surface rather than the physical properties of the resin used in board manufacture. The test covers the use of test specimens; gluing blocks; adhesives; loading fixture and speed; and reporting of results.

Appendix Revised

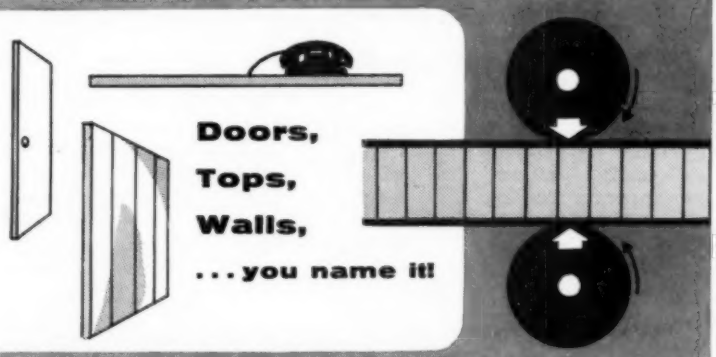
The Polystyrene Wall Tile Division of The Society of the Plastics Industry, New York, N. Y., has approved a revised Appendix to Commercial Standard 168-50 as part of an over-all program to further improve the quality and performance of plastic wall tiles and adhesives for their application. This SPI division, through its Adhesives Subcommittee, has developed these improvements in the installation and maintenance of plastic wall tile. The principal changes have to do with proper wall tile preparation and types of trowels to be used in the application of the mastic. Copies of the approved revision to the Appendix to CS 168-50 are available from SPI, 250 Park Avenue, New York 17, N. Y.

Caldwell Changes Name

The Caldwell Co., Akron, Ohio, in business 16 years as a manufacturer's representative and development company, has announced that its name has been changed to Americhem, Inc. The company represents such firms as Synthetic Products Co.; Greensboro Sales Division of Chas. Pfizer & Co.; Diamond Mica Co.; Thompson-Weinman & Co.; Resyn Corp.; and B. F. Drakenfeld Co. Americhem handles chemicals for the rubber, plastics and paint industries. The firm has developed a line of adhesives and color dispersions which is used for applying rubber and vinyl tile on and below grade. The company also has announced that its new headquarters will be located at 1651 Home Avenue in Akron.

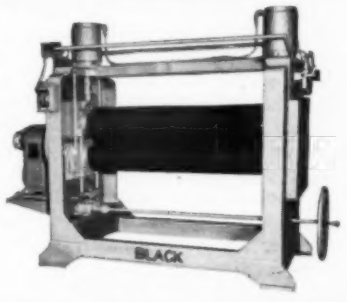
AUTOMATION for LAMINATION

of dissimilar materials — cement board, paper or metal honeycomb, plastics, fibre board, plywood, leather, linoleum, aluminum, stainless steel, and many other materials.



BLACK BROTHERS ROTARY PRESSES

Black Brothers rotary-type laminating presses are ideal for bonding dissimilar plies with pressure sensitive or contact adhesives — more precise, faster, more flexible. 8" through 134" capacities. Write for Bulletin 11-C.



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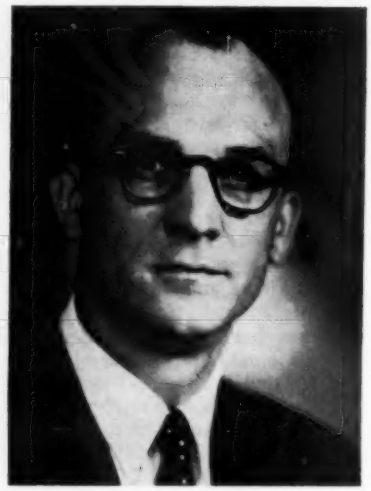

Gerald W. Burgoyne

Promoted by National Starch

National Starch and Chemical Corp., New York, N. Y., has announced the appointment of Norman Riley as a vice-president of National Starch and Chemical Co. (Canada) Ltd. Mr. Riley previously was manager of the firm's Montreal Division. Gerald W. Burgoyne, formerly sales manager of the Montreal Division, has been named to succeed Mr. Riley as division manager. The company also announced that John M. Shepherd has been promoted to superintendent of its Montreal plant.

Mr. Riley, who assumes administrative responsibilities for the entire Canadian company, has had wide experience in specialty chemicals used in the textile, food and paint industries. Prior to joining National in 1953 as manager of specialty sales, Mr. Riley was vice-president of O'Cedar Company of Canada, Ltd. Mr. Burgoyne is a graduate of the University of London, England, and is an associate of the Royal Institute of Chemistry. He joined the company as a technical service representative, and in 1955 was named technical service manager at the Montreal Division. He became sales manager in 1957. Mr. Shepherd joined National in 1958, after receiving his master's degree from the Harvard School of Business Administration. Prior to undertaking his graduate studies, he served as quality control foreman for Procter and Gamble in the Food Products Manufacturing Division. Mr. Shepherd holds a degree in chemical engineering from McGill University.

Changes Canadian Name

American-Marietta Co., Seattle, Wash., reports that the firm name of American-Marietta Company of Canada Ltd., has been changed to Canadian-Marietta Ltd. Canadian-Marietta Ltd. manufactures adhesives and resins for the plywood, paper, composition board and mineral wool industries throughout Canada, and has plants at New Westminster, British Columbia and Edmonton, Alberta. The company also supplies resin binders for foundry cores, shell molds and a new line of epoxy compounds.

Planning Glue Book

The Wood Gluing Division of the Forest Products Research Society, Madison, Wisc., reports that it is contemplating the preparation of a comprehensive book on the gluing of wood. According to the report, the preparation of such a book will be under consideration as a special project for the division. Other special projects also under consideration include the compilation of good papers on the subject of gluing; interpretative work on standards; and the compilation of a thorough bibliography.

Named By U.S. Rubber

U. S. Rubber Co., New York, N. Y., has announced that Schwartz Chemical Co., Long Island City, N. Y., has been named eastern distributor for its line of adhesives. The Schwartz company produces and distributes adhesives, cements, coatings and dyes for the plastics industries. The adhesives it manufactures are resin-based, and tailored for specific plastics applications. U. S. Rubber's adhesives are of a solvent variety, and are manufactured by its Footwear and General Products Division at Mishawaka, Ind. According to the company, chief uses for these adhesives have been in the automotive, furniture, aircraft and electronics industries.

U. S. Rubber states that it is currently expanding its adhesives line. Among new additions is a flame-resistant adhesive for bonding metal surfaces to wood, for office furniture; a cement for foam and polyurethane, also for the furniture industry; and a thermosetting cement to bond glass and jewelry to metal, for the jewelry industry.

Staley Names Two

A. E. Staley Manufacturing Co., Decatur, Ill., has announced that Natt K. Hammer has been named industrial products sales manager, and William J. Shaughnessy has joined the firm as a paper technical representative in the New York State territory. Mr. Hammer graduated from Millikin University in 1941, and joined Staley as an industrial sales representative in 1945 after serving four years in the U. S. Marine Corps. Mr. Shaughnessy is a 1954 graduate of New York State College, with a B.S. degree in pulp and paper technology. Prior to joining Staley, he was with the Albany Felt Co.

Building New Plant

American-Marietta Co., Seattle, Wash., has announced plans for the construction of a new synthetic resins and adhesives plant in Richmond, Calif. The new facility, part of a $30 million expansion program, is expected to have an annual capacity of 28 million pounds of resins and adhesives. According to the company, the expansion program also includes the enlargement of its resins and adhesives installations in the Pacific Northwest and Newark, Ohio.

Bonding Vinyl to Metals

A bonding of vinyl plastic and metals that promises to revolutionize the manufacturing and marketing processes of scores of consumer products was described by Edward B. Osborne (B. F. Goodrich Chemical Co.) at the annual National Metal Congress held recently in Chicago, Ill. Mr. Osborne remarked that radio and TV sets, household appliances, luggage, and even house sidings are gaining new dimensions in color, texture and durability through the burgeoning new trend to vinyl-coated steel and other metals. He pointed out that the markets for vinyl-coated metal are fabulous, and that vinyl could replace much of the enamel coating used in most applications except those where high temperature resistance is required.

Adds New Division

Atlantic Gummed Paper Corp., Brooklyn, N.Y., has announced the addition of a new manufacturing division. The new unit will be called the Polyethylene Coated Products Division and will be headed by Marvin Frankel, the company states.

Publishes Facts Book

The Manufacturing Chemists' Association, Washington, D. C., has announced that it has published the 1960-1961 edition of the "Chemical Industry Facts Book." Consisting of 20 chapters, the book covers such subjects as distinctive characteristics of the industry; what the industry makes; the industry's position in the national economy; the industry's raw materials; the industry's workers; the industry's plants; research and development; chemicals and nuclear energy; chemicals and defense; and chemicals and space.

PMMI Officers Elected

Packaging Machinery Manufacturers Institute, New York, N. Y., has announced the election of its officers who will serve two-year terms beginning in 1960. The following were elected: *President,* Kenneth B. Hollidge (Arthur Colton Co.); *First Vice-President,* W. R. Huguenin (Food Machinery Mfg. Co.); *Second Vice-President,* Harold Mosedale, Jr. (Package Machinery Co.); and *Third Vice-President,* William W. Anthony, Jr. (Crompton & Knowles Packaging Corp.).

Develops New Adhesive

Adhesive Products Corp., New York, N. Y., has announced the development of a new, non-inflammable bookbinding adhesive called Katex. The company claims that Katex makes it possible, for the first time, to bond vinyl plastic book covers to paper using the same methods and equipment used to adhere paper book covers. The company reports that Katex forms a strong, permanently-flexible, waterproof bond with plastics. The adhesive may be applied by brush, spray or machine and can be cleaned from equipment with soap and water, before it dries, the company states.

3M Building Plant

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has announced that a $4.5 million plant is now under construction at Decatur, Ala., for the production of fluorocarbon and other industrial chemical products. Completion of the plant is expected to be in early 1961. In addition, 3M reports that it will manufacture a complete line of specialty chemicals at the new plant.

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New Mystik Brand Super Flextron® Tape No. 6497 Has Bi-Directional Strength

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A-D-M Names Buell

Archer - Daniels - Midland Co., Minneapolis, Minn., has announced the appointment of Victor P. Buell as vice-president of marketing. According to the company, Mr. Buell will be responsible for long-range business planning, economic evaluation and corporate marketing analysis. He also will coordinate the firm's other marketing activities, including development of sales personnel, corporate advertising and public relations. Mr. Buell previously was manager of the Marketing Division of the Hoover Co. He is vice-president elect of the American Marketing Association. A graduate of Pennsylvania State University, Mr. Buell also attended the Advanced Management Program at Harvard University's School of Business Administration.

Borden Completes Plant

Borden Chemical Co., New York, N. Y., has announced the completion of a new pilot plant which is the first step in its $2.5 million expansion program at its Leominster, Mass., operation. The new pilot plant, operated by Borden's Polyco-Monomer Department, is designed to produce up to 1,000 pound lots of polyvinyl alcohol, polyvinyl acetate, acrylics, butadiene-styrene and other products. Construction now in progress at the Leominster site includes new development and technical service laboratories; a new unit for the production of butadiene-styrene products; a new polyvinyl alcohol plant; and facilities for the manufacture of Lemoflex, a special resin used in producing water-soluble packaging film. According to Borden, all the new facilities are expected to be completed and in operation early in 1960.

Sales Increase Reported

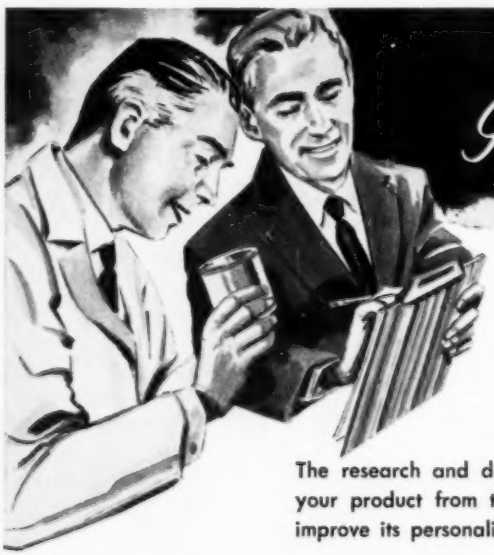
Reichhold Chemicals, Inc., White Plains, N. Y., has reported that its sales for the first nine months of 1959 had increased 31 per cent above the same period the year before. Sales for the 1959 period totaled $71,147,000, compared with $54,-434,000 for the 1958 period. Earnings for the first nine months of 1959 amounted to $2,590,000, equal to 85¢ per share of common stock, compared with $2,448,000, or 72¢ per share, for the like 1958 period.

3M Files Patent Suit

Minnesota Mining & Manufacturing Co., St. Paul, Minn., reports that on August 11, 1959, it filed suit against Armstrong Cork Co., Lancaster, Penna., and All-Steel Equipment Co., Aurora, Ill., charging an infringement of its Patent No. 2,-610,910. The patent covers neoprene-phenolic adhesive cement which is widely used by many segments of industry for bonding rubber, metal, fabrics, plastics, and plastic laminates. According to the company, the defendants have filed an answer to its charge, challenging the validity of the patent in question and denying infringement.

Forming Carton Group

The Packaging Institute, New York, N. Y., has announced plans for the organization of a Folding Carton Committee in its Materials Division. According to the institute, the objective of the committee will be to develop performance standards covering most of the factors involved with the use of folding cartons. Marshall Baldwin (Colgate-Palmolive) has been named launching chairman of the new group.



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Eastman Product Index

Eastman Chemical Products Co., New York, N.Y., has announced that the complete list of its industrial and specialty chemicals is now available in a newly published product index. The index, Bulletin No. P-102, features data on the physical properties of Eastman's industrial chemicals as well as shipping information. The bulletin is classified into seven sections: Acids and Anhydrides, Alcohols, Plasticizers, Aldehydes, Aromatic Intermediates, Solvents, and Miscellaneous Chemicals. Specialty products, described separately, include: Cellulose Products, Food Additives, Petroleum Additives, Epolene (low molecular weight polyethylene), Agricultural Chemicals, Sucrose Acetate Isobutyrate, and Eastman Dyes for synthetic textiles. In addition, a section of the six-page bulletin is devoted to newly developed products now available for evaluation.

3M Plans NAHB Exhibit

Minnesota Mining & Manufacturing Co., St. Paul, Minn., has announced that its exhibit booth at the National Association of Home Builders Exposition, to be held on January 17 to 21 at the Sherman Hotel in Chicago, Ill., will contain actual installations showing typical uses of a wide variety of new adhesives and sealers for home building applications. The company reports that two of the highlights of its display will be its new ceramic tile adhesives, designated CTA-20 and CTA-50, and a new series of polysulfide rubber base sealers, designated as Weatherban Brand building sealers. Other new products to be shown in actual installation at the 3M booth include wood block flooring adhesive EC-194; wall board adhesive EC-1233; Roltite Brand contact bond adhesives; and adhesives EC-104, EC-1128 and EC-321 for attaching all types of insulation.

Reports Higher Earnings

Morningstar-Paisley, Inc., New York, N. Y., reports that its consolidated sales for the nine-month period ended September 30, 1959, amounted to $19,018,687, an increase of 12 per cent over the same 1958 period. Earnings after taxes for the 1959 period totaled $499,860, an 18 per cent increase over the 1958 nine-month figure of $422,909. Earnings per share for the 1959 period amounted to $1.00, compared with 85¢ per share for the same period in 1958.

Roberts Names Aho

The Roberts Co., City of Industry, Calif., has named Jerry Aho to the post of production manager. Mr. Aho will be in charge of manufacturing facilities as well as development and engineering for all new products in the company's intensified product diversification and expansion program. Mr. Aho received his B.S. degree in mechanical engineering at Michigan College of Mining and Technology. Prior to joining Roberts, he was chief factory engineer at Marathon Electric Mfg. Co.; works manager at Rheem Mfg. Co.; and plant manager at Pioneer Mfg. Co.

Holding Annual Meeting

The Folding Paper Box Association of America, Chicago, Ill., will hold its annual meeting on March 22 and 23 at the Ambassador Hotel in Los Angeles, Calif. The association reports that the meeting will be preceded on March 21 by the traditional public showing of its folding carton competition. On March 30 and 31, all carton entries will be on public display at the Drake Hotel in Chicago, Ill., and on April 12, 13 and 14 at the New York Coliseum, New York City.

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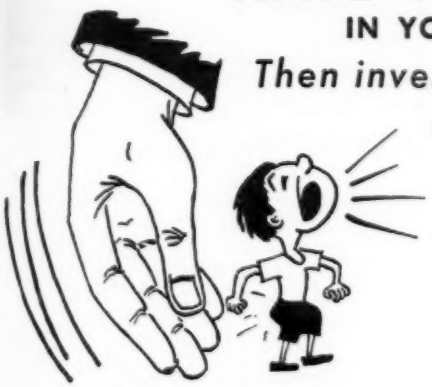

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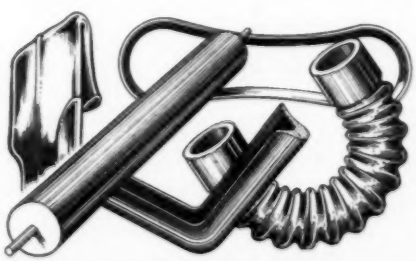

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Vulcanized Oil

THE STAMFORD RUBBER SUPPLY CO., STAMFORD, CONN.

The sales meeting of the Roberts Company was climaxed by a company banquet, attended by the sales group and key Roberts personnel. Guest speaker at the banquet was Dr. Harold Koontz, professor of marketing at the University of California at Los Angeles.

Roberts Holds Sales Meeting

The Roberts Co., City of Industry, Calif., recently held an intensive five-day series of meetings which was attended by its sales representatives from all parts of the nation. All the sessions were under the direction of L. E. Johnson, vice-president in charge of sales. Special emphasis at the meeting was given to Roberts' products, merchandising plans and distributor relations. Company officials who discussed their particular sphere of interest included C. E. Hopping, president; Hugh S. Livie and K. M. Bishop, vice-presidents and co-owners; Vern Clark, executive vice-president; Jerry Aho, production manager; Harvey Hill, industrial design; Dorothy Houghland, traffic and statistics; Wallace Taylor and Gerard DeBeau, Anchor-Weld Adhesive Division; and Frank Ford, advertising and sales promotion manager.

Bob Reid (William Volker & Co.) was one of the key speakers for the distributor sessions discussing "A Wholesaler Looks at a Manufacturer's Sales Representative." Specially prepared slide films, covering company background; Smoothedge carpet gripper, tools, accessories, and metal molding lines; and Anchor-Weld products were presented to the sales group. A banquet concluded the five-day meeting.

Adhesion Meeting Held

A symposium on adhesion and adhesives was presented on October 15 as part of the technical program at the Third Pacific Area National Meeting of the American Society for Testing Materials, which took place on October 11 to 15 at the Sheraton-Palace Hotel in San Francisco, Calif. Dr. Steven Yurenka (Narmco Industries) served as chairman of the symposium, which consisted of the presentation of four papers: "Surface Chemistry of Adhesion," by Samuel Muchnick (Remo, Inc.); "Lap Shear and Creep Testing of Metal-Adhesive Bonds in Germany," by Dr. Karl F. Hahn (Douglas Aircraft); "Elevated Temperature Resistant Metal-to-Metal Adhesives Derived from Organic-Inorganic Polymer Systems," by Edward C. Janis (Narmco Industries); and "Preliminary Evaluation of Ceramic Adhesives for Stainless Steel," by L. E. Gates and W. E. Lent (Hughes Aircraft).

Forms Study Committee

The Packaging Institute, New York, N. Y., has announced the formation of a committee to study the complex and far-reaching effects on packaging of the 1958 Food Additives Amendment to the United States Food, Drug and Cosmetic Act. To be known as the Packaging Committee on Food Additives Problems, this group is expected to provide industry-wide and sustained attention to the vital problems involved in compliance with the Food Additives Amendment. Due to the broad scope of the work envisioned for this committee, it will operate outside the present technical committee organization. Although technical problems will be studied as part of the committee's program, many important problems of a non-technical nature will also be considered. Roger V. Wilson (Continental Can) has been named launching chairman of the new committee.

Baker Addresses Council

Melvin H. Baker, chairman of the board of National Gypsum Co., Buffalo, N.Y., was the featured speaker at the annual meeting of the Rubber & Plastic Adhesive & Sealant Manufacturers Council on September 24, at the Hotel Stuyvesant in Buffalo, N.Y. The subject of Mr. Baker's talk was "A Decade of Great Growth in Construction." Mr. Baker remarked that from a relatively minor role in the past, in more recent years adhesives and sealants have become important elements in building, and further research should make them much more important in the future of construction.

Mr. Baker noted that in practically every phase of construction today, there is a swing toward units fabricated off site and designed for rapid assembly on site with minimum labor and in minimum time. He pointed out that this strong trend toward component construction will inevitably involve greater reliance on adhesives and sealants.

3M Sets Sales Record

Consolidated sales of $112,377,309 and earnings of $15,145,895, or 89¢ per share of common stock, were reported by Minnesota Mining & Manufacturing Co., St. Paul, Minn., for the three-month period ended September 30. This compares with sales of $95,104,809, and earnings of $11,921,415, or 71¢ per share, for the same period last year. The current sales figure is a three-month period record high for the company.

For the first nine months of 1959, sales totaled $323,079,201, with earnings of $42,583,641, or $2.50 per share, compared with sales of $271,366,401, and earnings of $29,568,080, or $1.75 per share, for the like period of 1958.

Named Section Head

Goodyear Tire & Rubber Co., Akron, Ohio, has named Bruce Habeck as head of a new Adhesive and Chemicals Section in its Chemical Materials Development Department. Mr. Habeck is a graduate of the University of Wisconsin, and his 17 years with Goodyear have been in chemical engineering and research. According to the company, the new section will lend technical support to its expanding effort in adhesive and basic chemical fields.

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Jan. 6-8. American Management Association, Packaging Division, Foams for Packaging Meeting, New York, N.Y.

Jan. 12-15. Society of Plastics Engineers, 16th Annual Technical Conference, Conrad Hilton Hotel, Chicago, Ill.

Jan. 17-21. National Association of Home Builders Exposition, Sherman Hotel, Chicago, Ill.

Jan. 25-28. Plant Maintenance & Engineering Show, Convention Hall, Philadelphia, Penna.

Jan. 26-27. Society of Vacuum Coaters, Annual Conference, New York, N.Y.

Jan. 26-29. Canadian Pulp & Paper Association, Technical Section, Queen Elizabeth Hotel, Montreal, Quebec, Canada

Feb. 2-4. 15th Reinforced Plastics Division Conference, Society of the Plastics Industry, Edgewater Beach Hotel, Chicago, Ill.

Feb. 4-6. American Society for Metals Conference, Fairmount Hotel, San Francisco, Calif.

Feb. 8-10. Fifth Joint Military-Industry Packaging & Materials Handling Symposium, Sheraton Park Hotel, Washington, D.C.

Feb. 14-18. Hobby Industry Association, American Trade Show & Convention, Sherman Hotel, Chicago, Ill.

Feb. 15-17. ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products, Shoreham Hotel, Washington, D.C.

Feb. 18-19. Chemical Institute of Canada, Divisional Conference on Protective Coatings, Toronto, Ontario, Canada

Feb. 22-25. TAPPI 45th Annual Meeting, Hotel Commodore, New York, N.Y.

Mar. 9-11. Instrument Society of America, Temperature Measurement Symposium, Deshler-Hilton Hotel, Columbus, Ohio

Mar. 22-23. Folding Paper Box Association of America, Annual Meeting, Ambassador Hotel, Los Angeles, Calif.

April 6-9. Society of the Plastics Industry, Western Section Annual Conference, Hotel Riviera, Palm Springs, Calif.

April 24-May 3. German Industries Fair, Hanover, West Germany

April 25-26. American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference, Chase and Park Plaza Hotels, St. Louis, Mo.

May 20-31. International Plastics Exhibition, Oslow, Norway

May 23-25. TAPPI 11th Coating Conference, Edgewater Beach Hotel, Chicago, Ill.

May 23-26. American Society of Mechanical Engineers, Design Engineering Conference & Show, Statler Hilton Hotel, New York, N.Y.

June 1-10. International Chemical Exhibition, Belgrade, Yugoslavia

June 5-9. Forests Products Research Society, 14th National Meeting, Montreal, Quebec, Canada

June 10-26. Federation of British Industries Exhibition, New York Coliseum, New York, N.Y.

June 13-15. 43rd Annual Conference and Exhibition of the Chemical Institute of Canada, Chateau Laurier Hotel, Ottawa, Ontario, Canada

Portrait Of

R. F. BLOMQUIST

As his primary professional interest, R. F. Blomquist cites "the development and use of better adhesives for wood, paper, metals and plastics and the development of new and improved adhesive-bonded products." Head of the Glues and Gluing Section, Division of Timber Processing, U.S. Forest Products Laboratory in Madison, Wisc., he has directed an extensive research program on properties, use characteristics and the durability of wood glues.

In addition to the above, Mr. Blomquist is also in charge of an armed services sponsored research and development project on metal-bonding adhesives and processes. This has included some pioneer work on metal-bonding adhesives for high temperature service.

Mr. Blomquist received a B.A. with majors in chemistry, physics and mathematics from Coe College in 1934. He obtained an M.S. and Ph.D. in organic chemistry from the University of Iowa in 1936 and 1937 respectively. Chairman of the ASTM Committee D-14 on Adhesives from 1954 to 1958, he now heads the Committee's special subcommittee on wood adhesives. He also served as chairman of the 1956 Gordon Research Conference on Adhesion.

Mr. Blomquist has authored and co-authored numerous technical articles which have appeared in ADHESIVES AGE, and other industrial publications.

names in the news

Dr. Robert G. Picard, director of research and engineering development for Central Scientific Co., has been elected a vice-president of the firm.

C. A. McKenzie has been appointed manager of special projects in the economics and development group at Polymer Corp., Ltd.

Lloyd C. Jackson, previously with Minnesota Mining & Mfg. Co., has been named materials engineer in adhesives and sealants at Bendix Aviation Corp.

Bernard H. Lorant has been appointed assistant to the president of Velsicol Chemical Corp.

Dr. Albert J. Klemka, previously with Behr-Manning Co., has been named technical director of Morgan Adhesives Co.

William T. McLaughlin has been promoted to field sales manager for the Protective Coatings Division of Pittsburgh Coke & Chemical Co.

Leonard J. Wood has been appointed product manager of the Paper Division at National Starch & Chemical Corp.

Dr. Carlisle M. Thacker has been named technical director of Taylor Fibre Co.

M. M. Gruber, formerly head of coatings and resins sales for Ciba Products Corp., has been appointed sales manager, and **Elliott N. Dorman,** formerly head of structural resins sales, has been appointed technical sales manager. **Richard H. Malamphy** has joined Ciba as manager of new products.

Dr. Augustus B. Kinzel, vice-president for research at Union Carbide Corp., has been named recipient of the Industrial Research Institute Medal for 1960.

Joseph C. Duke has been appointed executive vice-president for sales administration and public relations at Minnesota Mining & Mfg. Co.

George R. Hunt, Jr., formerly with Nalco Chemical Co., has joined Minnesota Mining & Mfg. Co., as a senior chemist.

Dr. Edward F. Thode has been named chief of the Pulping and Papermaking Section of the Institute of Paper Chemistry.

W. W. Mein, Sr. has been elected to the board of directors of Flintkote Co.

Col. Roy W. Muth has been assigned commandant of the Army Chemical Center and Chemical Corps Material Command at Edgewood, Md.

Thomas L. Daniels, board chairman of Archer-Daniels-Midland Corp., has been appointed to a United States Senate advisory committee on foreign trade.

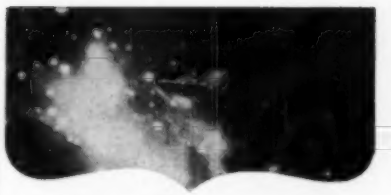
Frank A. Bovey, George V. D. Tiers and **George Filipovich,** of the Central Research Department at Minnesota Mining & Mfg. Co., have been given the annual Carbide Award by the Paint, Plastics and Printing Ink Division of the American Chemical Society.

Edward H. DaCosta, vice-president in charge of sales for Taylor Fibre Co., has been elected to the board of directors of the firm.

R. B. Rohrer has been named associate director of the Research and Development Center of Armstrong Cork Co.

Burton W. Schroeder, formerly manager of the Chemical Products Division of Archer-Daniels-Midland, has been named administrative vice-president of A-D-M. **George K. Nelson,** previously director of development at A-D-M, succeeds Mr. Schroeder.

James Bennie, formerly with Northern Utilization Research and Development Division of the United States Department of Agriculture, has joined Armour Industrial Chemicals Co.



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patent review

By MELVIN NORD

Recovery of Waste Coated Fibers

U. S. Patent 2,895,176, issued July 21, 1959 to Worth Wade and assigned to American Viscose Corp., provides a method for the recovery of waste fibrous filter batts from the manufacture of textile materials. As shown in the figure, the expended filter batts which preferably contain 10-80 per cent by weight of a potentially adhesive material are deposited in the magazine (3) and are periodically ejected from the open end of the tubular member or duct (4) into the vat (5). The batts as they are discharged from the duct (4) are deposited beneath the surface of a solvent on the endless perforated conveyor (7). As the batts travel on the conveyor (7) between the pulleys (9) and the sprockets (16a), they are submerged in a suitable solvent for the potentially adhesive material with which the batts have been thoroughly impregnated. In this way the edges and other relatively uncoated and unimpregnated areas of the batts are treated with substantial amounts of the potentially adhesive material which becomes dissolved in the solvent bath. The belt (19) serves to maintain the batts submerged during a substantial portion of their travel through the solvent and the potentially adhesive material becomes uniformly distributed throughout the batts. As the batts proceed upwardly from the bath and move past the suction box (21), excess solvent is removed from each of the batts prior to their delivery to the hopper (22).

The relatively uniformly coated batts which have been deposited in the hopper (22) are then fed between the teaser rolls (25 and 26) which are positioned below the lower extremity of the hopper. By suitably driving either of the teaser rolls or both of them at different rates in any convenient manner, the component fibers of each of the batts are separated and disentangled one from another to form individual coated fibers. The coated fibers are then deposited upon the horizontally disposed conveyor belt (27) which extends between the pulley members (28 and 29). From the belt (27), the fibers are deposited in the container (30) where a washing operation coagulates and renders nontacky the potentially adhesive coating on each fiber. Thus a controlled quantity of any suitable washing solution (31) is delivered through the inlet line (32). The overflow pipe (33) extends upwardly through the bottom of the container (30) and maintains the desired liquid level. The fibers are carried through the bath (31) and upwardly between the squeeze rolls (34 and 35) into the drying chamber (36) by the endless conveyor belt (37). In the drying chamber, the fibers are transferred from the belt (37) to the horizontal conveyor (41). Air is delivered to the chamber (36) through the inlet pipe (44) and circulates upwardly and about the fibers on the conveyor (41). The receptacle (46) collects the dried fibers as they are discharged from the end of the belt (41).

Applying Adhesive to Flaps

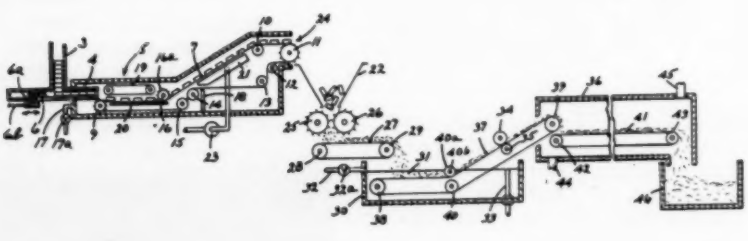
U. S. Patent 2,896,569, issued July 28, 1959 to John L. Ferguson, Sr., and Richard C. Talbot, assigned to J. L. Ferguson Co., describes a machine for applying adhesive to the flaps of a case or carton. It is common practice to apply an adhesive to the inner sides of the outer flaps of a case by a roller. Glue or other adhesive is thus applied in an uninterrupted film, following which these outer flaps are folded shut and maintained in a closed position until the adhesive has set or dried. The outer flaps are thus made to adhere to the inner flaps, so that the case is sealed shut. With such an arrangement for applying adhesive, a relatively long period of time is required for the adhesive to set or dry, which is objectionable since the flaps are necessarily maintained in their closed positions until the adhesive sets. According to the present invention, the adhesive is applied in small discrete areas, for example in narrow lines or in small dots. It has been found that when adhesive is so applied, it sets much more rapidly than when the adhesive is applied in a large uninterrupted film. This means that the flaps need be held in their closed positions for a relatively short period of time after application of the adhesive.

Glue Setting Accelerators

U. S. Patent 2,899,327, issued Aug. 11, 1959 to Edward F. Christopher and Harland H. Young, assigned to Swift & Co., provides animal glue and gelatin compositions with a substantially increased rate of set, without substantially increased gel strength. For example, 10 parts of triethanolamine citrate were added to a 45 per cent solution of bone glue. After mixing thoroughly, the heavy solution was chilled to strips of jelly and dried by passing first cold and finally warm air over the strips. The dried glue was a tough, leathery flake material which, when reconstituted to a 40 per cent solution, set in about one-half of the time required by the original glue.

Resin-Blood Glue

U. S. Patent 2,895,928, issued July 21, 1959 to Charles N. Cox and assigned to American-Marietta Co., describes a process of making a resin-blood glue. The glue base is prepared by forming a uniform, stable, aqueous dispersion of finely divided, undried, coagulated blood particles (e.g., by passing fresh coagulated undried blood through a colloid mill in aqueous suspension). Caustic soda and a thermosetting resin are then added to the glue base, and the glue is then ready for use.



Other Patents of Interest

Subject	Inventor or Assignee	Patent No.	Date
Mechanism for adhering gummed tape to the top flaps of an envelope assembly	Uarco Inc.	2,895,534	7/21/59
Filament reinforced gummed tear-tape	Minnesota Mining & Mfg. Co.	2,895,865	7/21/59
Adhesive composition for joining cores and molds	Diamond Alkali Co.	2,896,280	7/28/59
Pressure-sensitive adhesive tape	Minnesota Mining & Mfg. Co.	2,897,960	8/4/59
Adhesive bandage	Johnson & Johnson	2,897,961	8/4/59
High bonding strength adhesive composition	Phillips Petroleum Co.	2,898,315	8/4/59
Machine for adhesively forming a manufacturer's joint in a folded carton blank	Clifford D. Keely et al	2,898,816	8/11/59
Folding and gluing machine	S&S Corrugated Paper Machinery Co., Inc.	2,898,819 & 821	8/11/59
Tape dispenser	Derby Sealers Inc.	2,899,198	8/11/59
Positioning an adhesive strip	E. I. du Pont de Nemours & Co.	2,899,200	8/11/59
Cements for bonding high polymer sheets to each other	Eastman Kodak Co.	2,899,348	8/11/59
Method for bonding liner materials	Owens-Illinois Glass Co.	2,899,349	8/11/59

Raising Resin Output

U. S. Industrial Chemicals Co., a division of National Distillers & Chemical Corp., New York, N. Y., has announced plans to boost production capacity of polyethylene resins by 50 million pounds. The company reports that the proposed resin production increase will bring its annual resin capacity to 300 million pounds. USI's plant at Houston, Texas, which began production in March, has already doubled its resin output from 75 to 150 million pounds, and with the proposed expansion it is expected to reach a capacity of 200 million pounds annually. The company's Tuscola, Ill., plant is producing polyethylene at the rate of 100 million pounds a year. USI states that the current projected expansions are slated for completion by mid-1960.

ASTM Pacific Meeting

The American Society for Testing Materials held its Third Pacific Area National Meeting on October 11 to 16 at the Sheraton-Palace Hotel in San Francisco, Calif. The technical program consisted of 53 separate sessions with over 225 technical papers presented. A symposium on adhesion and adhesives was held on Thursday, October 15. Dr. Steven Yurenka (Narmco Industries) served as symposium chairman, and the following papers were presented: "Surface Chemistry of Adhesion" by Samuel Muchnick (Remo, Inc.); "Lap Shear and Creep Testing of Metal-Adhesive Bonds in Germany" by Dr. Karl F. Hahn (Douglas Aircraft); "Elevated Temperature Resistant Metal-to-Metal Adhesives Derived from Organic-Inorganic Polymer Systems" by Dr. Edward C. Janis (Narmco Industries); and "Preliminary Evaluation of Ceramic Adhesives for Stainless Steel" by L. E. Gates and W. E. Lent (Hughes Aircraft).

Develops Epoxy System

Houghton Laboratories, Inc., Olean, N. Y., has announced the development of a new shock resistant epoxy casting system. Designated Hysol 6622, the system is designed for embedding electric motor stators and transformers, and is also suitable for casting or potting large masses where exotherms cannot be tolerated, the company claims. Hysol 6622 is reported to be excellent for potting circuits and transformers having strain-sensitive elements.

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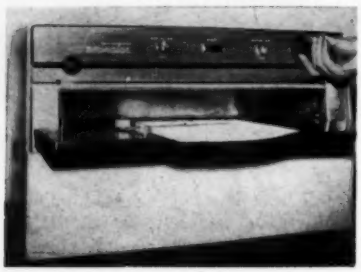


dial heat range of 120° to 380°F., and a variable processing speed, ranging from 12 to 25 feet per minute. It is designed to encase valuable papers, drawings or photographs in a thin, pliable film which acts as a tough, invisible protector against stains, grease, acids and rough handling. Independent of the heat dial, the laminator's speed control makes it possible to seal all originals regardless of thickness. Materials up to 17 inches wide by any length up to the 2,000 foot roll capacity can be encased automatically at a production speed set by the operator. *General Binding Corp.* **E-148**

Chemical Blender

The continuous tumbling action of the chemical mixer blends chemicals right in their containers, and is ideal for mixing 5-gallon containers. Two infra-red lamps, mounted on the mixer frame, quickly bring container contents to the proper temperature. The mixer is powered by a 115 volt AC-DC, continuous duty, gear head motor, with V-belt drive and pulleys. For easy loading and unloading, the mixer is fitted with a belt tension lever, which in the released position allows the basket of the mixer to be manually operated as a tilter for pouring contents directly from the container. *General Scientific Equipment Co.* **E-149**

Cleanliness Tester

A Model CM-1 Cleanliness Tester makes it possible to assign numerical values to surface cleanliness where non-bonded soils are involved. Typical applications that have been found for the device—plating, lithographing, organic coating, adhesive bonding—are operations whose success depends on the absence of foreign matter. The tester has a linear scale from 0 to 1000, a ten-turn potentiometer giving it an accuracy of one part in a thousand, which is said to make it superior to cruder methods like water-break and wipe tests. In testing, soil is first removed from a surface with transparent, pressure-sensitive tape, which is then affixed to a microscope slide. Direct readings are obtained by the tester, a densitometer that measures tape, soil and slide. *Branson Ultrasonic Corp.* **E-150**

Corrosive Liquids Pump

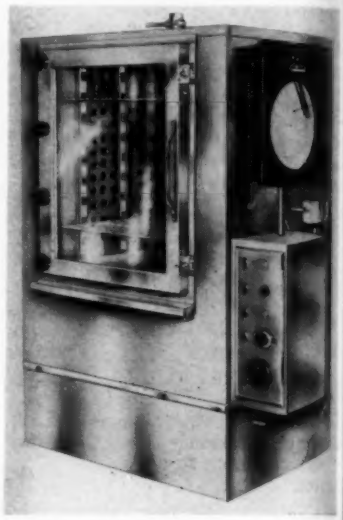
The SS Gear Pump is used for pumping corrosive liquids. The body and cover of the pump are stainless steel, as is the drive shaft, the idle shaft and one gear. The idle gear is Teflon. It is so constructed that stainless steel does not contact stainless steel and Teflon does not contact Teflon. According to the manufacturer, this insures greater strength as well as chemical resistance. A self-priming, positive displacement type, the pump has a top operating pressure of 100 psi. It is available in two sizes, ¾ inch and ⅜ inch, and both models have 0.836 gallons per 100 revolutions capacities. *Lobee Pump & Machinery Co.* **E-151**

Proportioning Pump

A diaphragm-type pump, Model 1331 Proportioneers Chem-O-Feeder is made of corrosion-resistant materials and will effectively meter many corrosive acids and chemicals. The company reports that the positive displacement pump is easily installed, either floor, shelf or wall mounted, and takes suction directly from the shipping container. Range is reported to be over 4 to 1 with capacity up to .7 gph into discharge pressures up to 100 psi *B-I-F Industries, Inc.* **E-152**

Environmental Chamber

Temperature and humidity are controlled automatically in a testing chamber for thermosetting and moisture-resisting adhesives. The chamber can be heated to 100° C. at up to 9[illegible] per cent r.h. The heating and humidity systems are self-contained, and



an indicating recording controller for both conditions is supplied. A full-length door window allows continuous observation of test samples. In addition to temperature proof and temperature testing, the unit is also suitable for analysis of adhesive setting temperatures and accelerated aging. *Electric Hotpack Co., Inc.* **E-153**

Hold-Down Clamp

Added to the company's Jorgensen line of clamping devices, the Hold-Down clamp holds work firmly on any surface without being limited to positions near an edge. The clamp attaches to any wood or metal work surface by means of a bolt spotted in the middle or along the edge of the work area. A slot in the base of the clamp engages the protruding head of the holding bolt so that the clamp slides into work position instantly. According to the manufacturer, this installation feature makes the clamp quickly adaptable in home, woodworking and metalworking shops for mitering, gluing, routing, sanding, mortising and many other jobs where speedy, sure holding pressure is needed. If installed along the edge of a workbench or table, the clamp doubles as a vise, the company states. *Adjustable Clamp Company.* **E-154**

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Portable Moisture Measurer

A portable thermistor psychrometer, the A+Hygrophil unit accurately measures the moisture content of air by means of wet and dry thermistor beads in a matter of seconds. The portability and rapid response features of the pistol-like instrument make it ideal for air moisture determination in textile factories, paper mills, store rooms and warehouses, packaging departments, printing plants, laboratories, and mines, the company states. Battery operated, the instrument has three scales for measuring humidity in temperatures ranging from 10° to 176°F., or −10° to 80°C. Accuracy is within 0.5 per cent of relative humidity and readability with ¼°F. To operate in places with explosion hazards, A+Hygrophil can be fitted with a spring coil motor, instead of the battery powered motor of standard design. *Atkins Technical, Inc.* ***E-155***

Cone-Plate Viscometer

A cone and plate viscometer is designed for testing of complex systems with non-Newtonian characteristics over a wide range of shear rates. The new operating principle is said to avoid many of the limitations and inaccuracies encountered with capillary or coaxial cylinder viscometers due to non-uniform shearing within the sample as well as stress-induced heating. The instrument is easy to fill, clean and operate. Three models can process very small samples to temperatures of 30, 100 and 200° C. *Ferranti Electric, Inc.* ***E-156***

Thermal Heater

The unit is lightweight, thin and flexible and can be used for airborne and electronic equipment applications. This Thermal-Heater is a 43 watt circular heater which weighs less than ¼ ounce, including 12 inch leads. It is less than .030 inch thick over the element and less than .065 inch thick over the leads, and it may be clamped or cemented in place. The flexible construction permits its application to flat or curved surfaces. Insulation resistance is 1,000 volts rms. *Minco Products.* ***E-157***

FOR MORE INFORMATION on the new equipment items described here, use the Reader's Service Card elsewhere in this issue.

Blow-Off Valve

The valve, called the Unit Tandem blow-off valve, is for boiler blow-off pressures up to 665 psi, and has a basic rated pressure of 400 psi. A forged steel block forms a common body for both the hard seat and blowing valve and the seatless sealing valve. The hard seat blowing valve

is of the Welbond type with an integral welded stellite seat. This design permits no leakage between seat and body. The valve stem is Type 303 stainless steel which gives adequate protection against pitting. The sealing valve is of a seatless design, and parts are interchangeable with existing Type B seatless blow-off valves. The seatless valve gives positive closing with tight seal. Medium pressure Unit Tandem valves are available either with flanged or welding ends, right or left hand assembly. *Yarnall-Waring Co.* ***E-158***

High-Speed Tester

A high-speed testing machine, the Plastechon is a precision instrument designed to measure tensile, flexural and compression properties of materials at rates of loading of 6,000 to 12,000 inches/minute, depending upon the modulus of elasticity of the materials being tested. The manufacturer states that the Plastechon is a valuable tool for predicting, in the laboratory, how a material will behave in applications where shock loads are encountered. The unit also can be used to test the effects of rate of loading on shear stress of bonded materials. The Plastechon consists of two component assemblies: a pneumatically actuated tester, and an electronic measuring system. Stress time or stress strain curves in the millisecond range are picked up on an oscilloscope and recorded on film. Longer term stress relaxation phenomena are measured on a strip chart recorder. *Plas-Tech Equipment Corp.* ***E-159***

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- **Adhesive Bonding for Fibrous Glass Reinforced Plastics—H. A. Perry. $8.75.** A theoretical and practical manual on the joining of glass reinforced plastics. ☐

- **Adhesion and Adhesives—N. A. De Bruyne and R. Houwink. $13.50.** A collection of information on the scientific and technological aspects of adhesion. Part I deals with theory, while Part II is devoted to the technology of adhesion. ☐

- **Epoxy Resins—Their Applications and Technology—H. Lee and K. Neville. $8.00.** Guide to the field of epoxy resins, covering the chemistry of their preparation and applications, including a section on adhesives. ☐

- **Polyamide Resins—Donald E. Floyd. $4.50.** Discusses in detail various important applications of the polymers belonging to the polyamide resin family and includes a comprehensive section on adhesives. ☐

- **Principles of High Polymer Theory and Practice —A. X. Schmidt and C. A. Marlies. $13.50.** Study of the principles of high-polymer theory and practice, with a section on adhesives, their applications, and mechanisms and factors involved. ☐

- **Recent Advances in Gelatine and Glue Research —G. Stainsby (Editor). $12.00.** Study of Collagen, and its protein gelatine, comprising papers and Proceedings of an International Conference of the British Gelatine and Glue Research Association. ☐

- **Rubber-to-Metal Bonding—S. Buchan. $4.00.** Discusses methods for bonding natural and synthetic rubbers to metals of all kinds, for use by those who manufacture rubber-metal units, and of interest to the rubber-minded engineer. ☐

- **Vinyl Resins—Mayo Smith. $5.75.** Surveys applications of vinyl resins with information on their types, properties, chemistry, manufacture and fabrication. Includes information on several types of adhesives in this category. ☐

- **Epoxy Resins—Irving Skeist. $5.50.** A chapter on adhesives is included in this complete study of the entire field of epoxy resins. The author gives formulations, trade names, methods of manufacture and applications. ☐

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Hot Organic Coatings. ***By Raymond B. Seymour. Published by Reinhold Publishing Corp., 430 Park Avenue, New York 22, N.Y. 6 x 9 in. 233 pp. $7.50.***

The past 15 years have witnessed a dynamic growth in the usage of hot organic coatings throughout the world. The hot application technique, which has been accepted as standard by pipe coaters and waterproofers, is finding its way into many phases of printing, paper coating, packaging, adhesives and protective coatings. Although it is too early in this rapidly changing field to expect a "definitive textbook," a broad survey of recent developments from a practical engineering standpoint has been badly needed. This book by the president of a California plastics firm meets that need.

Separate chapters are devoted to the most widely used hot organic materials, including asphalt, coal tar pitch, petroleum waxes, synthetic hydrocarbons, cellulose derivatives, and animal, vegetable and insect waxes. These are followed by information on hot melt applications without solvent such as peel coatings, protective linings, flame spraying and the fluidized bed process. Frequent references are made to adhesives and typical formulations are supplied for hot-melt materials.

A unique feature of this volume is its review of the many base materials —metals, textiles, wood, paper and concrete—to which plastic coatings can be applied. Chemical resistance characteristics and physical properties of materials used in coatings are detailed, however generally without reference to the literature source. General test procedures for determining the quality of hot organic coating compounds after application are summarized. In keeping with its slant to the engineer and industrial technician, the book emphasizes relative cost factors of various application methods.

Techniques of Polymer Characterization. ***Edited by P. W. Allen. Published by Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y. 8¾ x 5½ in. 256 pp. $9.50.***

The past decade has seen the development of many new techniques in the measurement of polymeric substances, many of them either unpublished or dispersed throughout the literature. This collection by eight English scientists and industrial chemists fills a growing need for a critical, up-to-date evaluation of the more important methods used to characterize high polymers. It represents a valuable complement to the recent number of excellent books which were generally restricted to theoretical rather than practical laboratory aspects of the subject.

Following an introduction on solvents and the preparation of polymer solutions, these topics are covered: (1) Fractionation of High Polymers, (2) Number-Average Weights by Osmometry, (3) Other Methods for the Determination of Number-average Molecular Weights, (4) Light-Scattering Techniques, (5) Viscometry, (6) Techniques of End-Group Analysis, and (7) Characterization of Block and Graft Copolymers. Dr. P. F. Onyon has written a highly informative chapter on viscometry, concentrating on the principles and procedures of capillary tube systems.

The book was designed primarily for the graduate chemist familiar with the major works on the subject, but without practical experience in handling and performing measurements on polymeric substances. It has achieved this purpose admirably and should prove equally useful to the more experienced worker who wants to keep abreast of the latest international developments in the field.

Continuous Analysis of Chemical Process Systems. ***By Sidney Siggia. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. 6 x 9 in. 381 pp. $8.50.***

Details on all phases of the new analytical devices designed to attain economical, accurate and continuous monitoring of chemical process systems are presented in this volume. These are shown to differ from conventional lab devices in that the on-stream analytical instruments function automatically, hooked up directly with the processing equipment or pipeline. Further, recorder charts and dial readings permit a constant check of the chemical composition in the process systems.

The up-to-date technical information in this volume was culled from journals, commercial literature and personal communications, then reviewed by the instrument companies manufacturing analytical devices. Each instrument is described according to principle of operation, range of application, accuracy and precision, installation and construction specifications, time for response, use with controllers, versatility and interferences. Examples of specific applications are also given for each instrument.

The text is tailor-made for practicing analysts and engineers who have to establish plant control systems. The chapter on viscosity measurement should prove particularly helpful to adhesives manufacturers who would like to convert to a modern monitoring system as an ultrasonic vibration probe instrument connected to a computer. In addition, students of this field will find here a portion of instrument analysis not covered in the usual textbooks or in standard courses.

Trade Literature

Properties and Use of Atlac 382 Polyester Resin. Room Temperatures Curing System for Atlac 382. Two bulletins of 12 pages each describe the properties, applications and a room-temperature curing system for a new polyester resin. The first bulletin contains detailed instruction on using the resin and information on curing at elevated temperature. Also included are tables on chemical resistance, gel and reactivity times at various bath temperatures, properties of glass mat and glass cloth laminates, and viscosity graphs. The second publication lists some typical resin concentrations for room-temperature curing at specific gel times, as well as graphs of viscosities and gel times of resin solutions. *Chemicals Div., Atlas Powder Co.* **L-163**

Polymer Product Directory. Standard products listed in an eight-page booklet include polyvinyl acetate emulsions and solutions, styrene-butadiene emulsions, acrylic emulsions and solutions, polystyrene emulsions, sodium polyacrilate thickeners, vinyl and vinylidene chloride emulsions, polyvinyl alcohol and polyvinyl acetate bead resins. Chemical properties and recommended uses for each product are enumerated in tabular form. This arrangement lends itself well to reference use. *Polyco-Monomer Dept., Borden Chemical Co.* **L-164**

GenEpoxy Resins. The physical and chemical properties, specifications, and uses as protective and decorative, solvent and solventless, concrete surface, fluidized bed coatings of GenEpoxy resins are described in this 24-page booklet. The booklet also lists formulations for urea-formoldehyde resins are described in this 24- adhesives, castings, and laminates. Suggested curing and release agents, data on handling and storage, quantities available, and toxicity are also given. *General Mills.* **L-165**

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This new edition of Dr. Buchan's important and comprehensive work, has been completely revised and up-dated to include the many advances and new developments in the technology of bonding rubber-to-metal in the 10 years since the publication, in 1948, of the widely-acclaimed original edition. Describes processes, applications and methods in detail. Gives concise, straight-forward explanations of how to handle rubber-to-metal bonds at each stage of the job. Sufficient materials are included with each description to permit the reader to project given examples to his own needs. Written by the chief chemist of one of the most successful bonding firms in the world, this is the single most complete source of information about a subject of major technical importance to men working in the rubber adhesive industries.

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Bonding Agents, Polyisocyanates
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Borden's Chemicals, Polymers, Resins, Adhesives, Coatings. A 36-page, two-color product catalog and directory which lists specifications, end-uses, and other technical data for the more than 1,000 products manufactured and distributed by the company. Industrial and consumer products are reviewed in the general areas of basic chemicals, monomers, polymers, resins, adhesives, coating materials, plastic products, fine chemicals, organic intermediates, and bio-chemical reagents. The publication also lists the company's sales and service centers throughout the United States, its 17 plant locations, warehouse points, and eight overseas manufacturing subsidiaries. The directory is cross-indexed by product name and end-use. *Borden Chemical Co.* **L-166**

PVP/VA Copolymers. This is an expanded and comprehensive bulletin on new types of commercially available vinylpyrrolodone/vinyl acetate copolymers and their numerous applications. Designated Bulletin AP-88 Rev., the two-color, 20-page publication outlines recently developed uses of these acetylene-derived chemicals. Technical data are presented in charts, and practical formulations are given for use in adhesives, hair-grooming agents, protective films, shoe polish, plant spray, decorative sprays, and anti-tarnish coatings. *Antara Chemicals.* **L-167**

Cellobond Adhesive and Binder Resins. A new line of adhesive and binder resins is itemized in a 16-page data book. Eight sections present basic technical information clearly and concisely on the following groups of materials: adhesive resins, laminating resins, polyester resins, foundry resins, grinding wheel resins, brake lining resins, special phenolic polymers and rubber compounding resins. In addition to special adhesives for metals and plastics, standard types for wood-to-wood gluing include hot and cold setting phenolic, urea and resorcinol types. *British Resin Products Ltd.* **L-168**

Paper Tapes. The brochure details the basic construction and physical properties of the company's complete line of pressure-sensitive paper tapes. In addition, there is a listing of paper tape applications such as masking, packaging, sealing, protecting, holding, reinforcing and splicing which points out specific uses in various industries for these tapes. *Permacel.* **L-169**

Ty-Ply Rubber-to-Metal Adhesives. Adhesives Bulletin No. 1 contains up-to-date information on Ty-Ply adhesives. Ty-Ply types, general and detailed methods of use, bond characteristics and tie cements are explained from the standpoint of practical usefulness. A Ty-Ply price list is included. *Marbon Chemical Division.* **L-170**

Insurok Laminated Plastics. This eight-page catalog, No. 20.000.13, describes the industrial applications of Insurok laminated plastics as well as the firm's molded plastics. Typical applications of these plastic parts are described with illustrations. The catalog contains a chart which lists the various grades, characteristics and uses of Insurok industrial laminated sheets, in addition to data on such typical values as physical properties, electrical properties, mechanical properties and bonding strength. A section is devoted to examples of fabricating techniques. *Richardson Co.* **L-171**

Resyn 26-2404. A new vinyl acrylic copolymer solution which offers unique adhesion characteristics for lamination or pressure sensitive work is described in this four-page technical service bulletin. Technical data on Resyn 26-2404 is summarized and information on its compatibility with film formers, resins, tackifiers and solvents is also included. *National Starch & Chemical Corp.* **L-172**

Resiweld Epoxy. Resiweld adhesives, plastic alloys, sealants, coatings and current uses are described in this 44-page booklet, designated Resiweld Book No. 2. Product uses and characteristics are covered in five sections. *H. B. Fuller Co.* **L-173**

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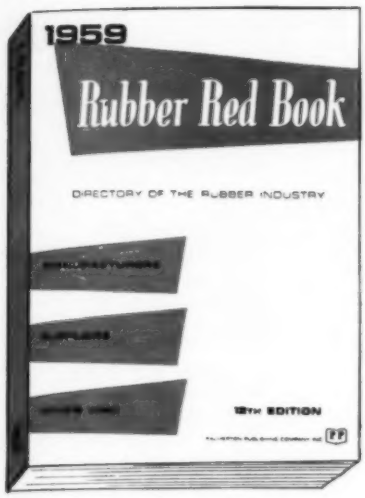

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More Definitions

The *National Casein Executive* has published a new list of business definitions supplementing those published in our October, 1959, issue. Their list goes like this:

A Policy—Common substitute for good judgment.

Calculated Risk—Crap shooting on a corporate level.

Well-Rounded Program—An excuse for running off in all directions at once.

Watchful Waiting—A dignified way of doing nothing.

Take Forceful Action—Do something that should have been done long ago.

Taking a Long, Hard Look—Cover-up for indecision.

Forward Looking—Not justified by past experience.

Merger—a form of musical chairs in which one or more executives are left without a seat.

Joint Venture—Marriage without love.

Diversification—Out of the frying pan into the fire.

Capital Gain—The substance executive dreams are made of.

Before Taxes—Wishful thinking.

Deferred Compensation—Gone today, here tomorrow.

Under Consideration—Somewhere in that stack of papers on the desk.

In Due Course—When we get around to it.

Underground TV

Adding to its already impressive efficiency and safety innovations, the Paris municipal subway has introduced closed-circuit televison in several of its stations where the platforms are curved along the track. Before the new set-up, subway engineers could not see around such bends to the last several cars of their trains and, consequently, employees had to be stationed in the middle of the platforms to signal the all-clear so the engineer could push the button to close the train doors and get underway. Now, a television camera is located where the employee was previously stationed. It transmits the image of the rear section of the train to a screen on the forward end of the station platform just before the engineer's front window.

Did You Know That

A company has been formed in New York to make and sell disposable paper clothing. The product line includes shirts, pants, laboratory or shop coats, aprons, overshoes and medical examination gowns . . . A recent survey shows that 60 per cent of 102 companies responding to a questionnaire put limitations on the number and rank of executives who may fly together. In many cases, no more than two or three key executives may be on the plane at the same time . . . A painful muscular disability known as "television bottom" is afflicting TV buffs. First word of the new ailment came from a Kentucky doctor who reported it to the International College of Surgeons . . . Long ball hitters can be robbed of home runs in cold, dry air and increasing barometric pressure. Why? Because on a cold, dry day the air is more dense than on a hot, humid day.

Soviet Tire Industry

Russia is rapidly automating its outmoded rubber industry, according to a top American rubber company executive. The Soviets have purchased enough 75-inch automatic curing machines, built under U.S. license and purchased from England, to turn out 20,000 truck tires a day. This means there is more of this modern tire curing equipment in Russia today than in the United States, the executive stated.

Inventive People

The United States Patent Office discloses that it is now issuing patents at the rate of 1,000 per week. The office has now issued a total of almost 3 million patents since it opened its doors in 1802. It would be interesting to know how many of the 3 million issued patents pertained to gadgets and how many actually represented significant achievement.

Oh Come Now Department

A Master of Science in Education degree has been awarded to a student at the Illinois State Normal University. The degree was awarded for the student's thesis entitled "Roadside Utilization Along Selected Bypass Sites U.S. Route 66 in Illinois."

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